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Glass Division Papers at the 60th Annual A.C.S. Meeting

• The American Ceramic Society held its 60th Annual Meeting at the Penn-Sheraton Hotel, Pittsburgh, Pennsylvania, April 27 to May 1. Because the Society was conceived at the Monongahela House in Pittsburgh, 1898, it was quite appropriate that it return to Pittsburgh on this memorable occasion. A plaque of photosensitive glass was mounted on the wall of the building that now occupies the site of the Monongahela House and was appropriately dedicated on the first day of the 60th meeting, Sunday afternoon, April 27.

Approximately 2,500 people were registered for this annual meeting, with visitors representing Mexico, Canada, South America, and several European countries. An interesting program of 17 papers devoted to glass technology was arranged by the following committee: chairman, J. R. Hensler, Chemical Research Laboratory, Bausch and Lomb Optical Company, Rochester 2, New York; Ralph K. Day, Libbey-Owens-Ford Glass Company, 1701 East Broadway, Toledo 5, Ohio; Robert M. Witucki, Aerophysics Development Corporation, Box 689, Santa Barbara, California.

The Monday afternoon session was capably guided by J. R. Hensler, session chairman, Bausch and Lomb Optical Company, Rochester, New York.

Pentagonal Ring Theory of Structure of Silicate Glasses by L. W. Tilton, National Bureau of Standards, Washington 25, D. C., was an invited paper and had been previously presented at the Gordon Conference (Glass) in Meriden, N. H.

The author proposes a new concept for the glassy state which is neither crystalline nor amorphous, solid nor liquid.

The vitron, a new concept for study of the glassy state, is postulated as a submicroscopic stressed cluster of definitely arranged but slightly distorted elemental groups or cages (such as pentagonal dodecahedra) which have noncrystal symmetry and are composed of smaller structural units (such as silicon-oxygen tetrahedra). Silica-rich glasses can be considered as continuous networks with modulation in stresses, force constants, and degrees of regularity from vitron centers to midpoints in the connective tissues.

There is considerable doubt that glass is homogeneous in a micro-sense. Models were exhibited to show that penta rings are quite likely to form in the glass structure. In addition, these rings are believed to unite to form 12-sided figures containing the 12 faces that form a vitron.

The proposed model is consistent with much known data on simple silicate glasses and permits some new explanations. Successful use of a simple additive formula for densities of alkali silicate binary glasses from annealing temperatures to 1400° C. is in accordance with the view that glass forms at temperatures above those favorable for crystalline structures.

Although the vitron concept explains many characteristics of glasses as well as certain anomalous features, further study is recommended to explain the more complex glasses.

On the Internal Structure of Borosilicate Glass by Electron Microscopy was written by M. Watanabe and H. Noake, Electrical Communication Laboratory, Nippon Telegraph and Telephone Corporation, Tokyo, Japan. The paper was presented by Dr. Watanabe.

Borosilicate glasses containing variable amounts of B_2O_3 and SiO_2 were studied by means of electron microscopy techniques. These glasses were of the Vycor type. A two-step replica procedure was described involving the use of acethyl cellulose with carbon and germanium shadowing.

Many electron-micrographs were obtained for boro-

silicate glass which had been subjected to chemical attack after heat treatment at various temperatures and durations in order to study changes in internal structure—the so-called "phase separation."

By a comparison of the surfaces before and after acid leaching, some knowledge of the phases leached out was obtained, and the approximate width and sizes of the residual skeletons were ascertained. The following conclusions appeared to be justified:

1. So-called "quenched state glass" contains a glassy micro-phase of alkali-borate, with dimensions less than 100 a.u., which corresponds to the so-called "low melting component."
2. The longer the heat treatment time under constant temperature the larger the size of this glassy microphase becomes.
3. Another kind of glassy microphase, SiO_2 rich, which corresponds to the so-called "high melting component" is also enlarged with increasing heat treatment time.
4. The size of both glassy microphases showed different values with different heat treatment temperatures.

I. Warshaw of the Pennsylvania State University showed some excellent electron micrographs of flat-glass surfaces of extremely high magnification. His results indicated that present methods of electron micrograph preparation were satisfactory and no evidence of granulation of Pt. or other replicating materials could be seen. Dr. Warshaw also concluded that the sizes of inhomogeneity in glass were of the order of approximately 40 a.u.

Activities and Structure of Some Melts in the System Na_2O-SiO_2 was prepared by W. J. Knapp and W. D. Van Vorst, University of California, Los Angeles, Cal. and was presented by Dr. Knapp. This paper provided another approach to a study of glass structure. Data were used from the liquidus curve of the phase diagram for the system Na_2O-SiO_2 developed by Kracek. The area involved was that between sodium metasilicate and sodium disilicate.

A structural model was developed for melts between Na_2SiO_3 and $Na_2Si_2O_5$, and its applicability was tested by comparison of activities computed from the model with activities determined from the calorimetric heat of fusion.

An ionic model involving three-membered $(SiO_3)_3^{-6}$ and $(Si_2O_5)_3^{-6}$ anions showed activities in good agreement with those determined from the calorimetric heat of fusion. A plot of log N_{SiO_3} versus log 1/T indicated a straight line. The use of a simple ionic model combined with ionic point depression made possible the production of a model showing the structure of liquid fusion. The use of cryoscopic data promises to be of considerable value in studying the structure.

New Uses for Flotation in Glass Technology by Charles H. Greene, State University of New York, College of Ceramics at Alfred University, Alfred, N. Y. gave another approach to structure of glass.

Dr. Greene presented a method of determining the density of glass which involved the use of a glass float of known density suspended in a liquid medium of known density. The liquid medium density was controlled by means of temperature regulation, using a method similar to that recently developed by Douglas.

An interesting dynamic model of the structure of silica glass was given composed of spherical silicon and oxygen "atoms" adjusted to match the density of a flotation liquid and coupled by magnetic "valence" forces. No data were given, but it is hoped that further work will be done with this interesting technique to show the structure of more complex glasses.

Fracture in Glass and the Interpretation of Fracture Markings by Sydney Bateson, Duplate Canada Ltd., Oshawa, Ontario, Canada, was the first offering on Tuesday morning, which session was under the chairmanship of Ralph K. Day, L. O. F. Glass Company.

Probably no subject has been so thoroughly investigated and reported in the literature as the fracture process in glass. Such authors as Smekal, Schardin, Kerkhoff, Poncelet, and Shand, to name but a few, have left very little unexplored territory. Nevertheless because some of the techniques which have been used to study fracture differ from the conventional, it was believed that a different appproach might aid the interpretation of fracture marks.

A review of the more common fracture markings in annealed commercial glass was presented.

It is interesting to observe the corresponding marks in plastic materials. Unlike glass, those visco elastic materials have a definite yield value beyond which the material is subject to non-recoverable plastic flow or creep. This may persist over long or short times and distort the shape of the object. In spite of this flow, materials such as cellulose acetate butyrate, rigid pvc, and acrylonitryl eventually fail with a characteristic brittle rupture even at room temperatures. The final rupture is remarkably independent of the previous history of the material.

The fracture markings, moreover, bear a striking similarity to those in glass. Hackle, rib marks, and the mirror are present in modified form. Frequently, the flaws themselves are visible. Their growth and relationship to the mirror have been studied. Apart from its practical value, the observation of fracture in plastic materials is an aid to interpretation because much of the phenomena to be observed in glass occurs in visco-elastic materials on a "giant scale" dimensionally and in "slow motion" temporally.

A heater strip technique, whereby local stresses can be set up at will, was used to study slow fracture propagation in annealed glass plates. The effect upon edge strength of tension or compression zones derived from the foregoing techniques was minutely examined, both in annealed and disannealed glass plates. Trends in the search for higher glass strength were discussed. With the heated strip, it is possible to maintain a reasonably constant stress over the whole course of fracture. The fractures are several inches long instead of being only a millimeter or so in length.

By means of ruling a series of short scratches across the fracture path at regular intervals, Wallner lines can be started from both glass surfaces without serious disturbance of the fracture front shape. Several methods of calculating the velocity ratio between the fracture and transverse wave were presented. Crossed Wallner lines

yielded a value uniquely independent of the fracture front shape with an accuracy of approximately 2 per cent. The other method of calculation, involving the establishment of the fracture front from a rib mark, is not nearly as reliable. All crossed Wallner line measurements were superior to those derived from loading experiments: first, because of the enlarged scale; second, because of the "wave guide" action along the heater strip which approximates a plane fracture front, perpendicular to the edges and independent of the position of the origin; and third, because geometry renders Wallner line calculation quite simple.

It was attempted to group the fracture velocities resulting from measurement of 16 Wallner line pairs according to their position with reference to grey and hackle formation. These observations showed a slight increase in velocity associated with fine hackle and a fall-off immediately beyond the coarse hackle region. The significance level was, however, low and further measurements are needed.

From the results of the work, the following were concluded:

1. *Absence of yield value.* Because glass does not flow under load, elastic energy is stored uniformly throughout the body, with the exception of local stress concentrations at the external loading points. Provided the loading is more or less uniform, the glass should accept elastic energy and store it up to the point at which the cohesive force is exceeded. This cohesive force is extremely high; consequently, the theoretical strength of the substance is greater than its actual strength. It should then be possible to utilize a major part of this theoretical strength, were it not for the intrusion of other factors.

2. *Factors contributing against possibility of a glass reaching theoretical strength.*

a. Surface flaws or defects act as stress-multipliers, and, consequently, a fracture may start at one of these areas, even at relatively low stresses.

b. Because the potential elastic energy is uniformly distributed throughout the glass, there is always some of it available to propagate the fracture. The greater the load, the more energy will be available and the more violent will be the fracture.

c. Because of the stress multiplying feature at the tip of a crack, only a relatively low tensional stress is required to propagate the fracture.

d. There is, therefore, a sequence of properties belonging first to the flaws and then to the crack tips themselves which tend to limit the strength of the glass.

The Effect of Temperature on the Strength and Static Fatigue of Glass was written by R. F. Mould, Preston Laboratories, Inc., Butler, Pa.

Dr. Mould presented details of comprehensive research directed toward a fundamental study of the strength of glass. Because fractures originate at flows on the surface of glass, the flows are purposely created and controlled by abrasion. Microscopic slides were used as test samples.

Detailed static fatigue curves were measured for abraded glass specimens immersed in distilled water at controlled temperatures between zero and 100 degrees centigrade. Load durations from 0.0025 sec. to one minute were employed. For any given load duration, strength decreased monotonically with increasing temperature, and at 100° C. it was approximately two thirds as great as at 0° C. The strength was also seen to decrease with duration of stress.

A comprehensive description of the effect of temperature from absolute zero to the softening point of glass

Seated, left to right: W. W. Coates, Jr., vice-president; Herbert Insley, vice-president; Harry E. Davis, vice-president; Richard S. Bradley, president; Oscar G. Burch, president-elect; and John F. McMahon, immediate past president. Standing are the three newly-installed trustees: E. E. Howe, Enamel Division; F. J. Von Tury, Design Division; and Rolland Roup, Electronics Division.

based on the results of Mengelkoch, Vonnegut, Jones, and Turner were also presented. The unusually high strengths of the latter were believed to be due to the sealing of surface flows brought about by grinding and polishing.

The paper discussed the possible effects of the growth of flaws resulting from the chemical interaction of water, producing severe stresses at the surface. The role of physically adsorbed water as well as that of chemically adsorbed water was discussed in detail.

Electromagnetic loading as a means of breaking was described.

The Effect of Temperature Gradients and Aspect Ratio on Viscous Flow Through Open Channels by Alfred R. Cooper, Jr., Ceramics Division, Massachusetts Institute of Technology, Cambridge, Mass.

This paper presented some theoretical results in regard to possible viscous flow of glass during melting and fusing operations. Because flow of glass in tanks and forehearths is considered similar to flow in open channels, numerical methods of calculating viscous flow using a single Navier-Stokes equation were employed. The velocity profile showing velocity in a tank and the effects of the side wall on velocity distribution were shown. By some investigators this effect is believed to be quite small.

The effects of the side wall upon velocity are said to be negligible when measurements are taken at a point farther from the wall than twice the depth of the channel. A surface temperature of 1500° C. of the glass was assumed as well as a constant temperature of 500° C at the bottom of the refractory.

Viscous Flow of Glasses and Relation to Visco-Elastic Effects was presented by Harold T. Smyth, School of Ceramics, Rutgers, The State University, New Brunswick, N. J.

This paper was highly theoretical and designed to provide a useful theory for explaining the viscous flow of glasses.

In a previously published discussion of viscous flow, the flow mechanism was assumed to be an exchange of neighbors in the neighborhood of an unsaturated silicon. A more detailed analysis of this mechanism shows that such an interchange of neighbors around a constant set of unsaturated silicons can lead only to a delayed elastic effect. If, however, the unsaturated silicons are constantly being produced and destroyed in such a way as to lead to a state of dynamic equilibrium, then it is possible to show that this leads both to a delayed elastic effect and to a steady viscous flow. Application of this theory to several simple glasses was discussed. This work is part of a program of study of the properties of glasses sponsored by the Office of Naval Research.

It is possible to calculate velocity, relaxation time, flow, etc. from this theory. It was emphasized, however, that this is only a theory and more work should be done before definite conclusions are possible.

Relations Between Rate of Stress Release and Viscosity in Soda-Lima, Potash-Barium and Borosilicate Glasses was written by D. A. McGraw and C. L. Babcock, General Research Division, Owens-Illinois Glass Company, Toledo, Ohio. The paper was given by Dr. McGraw.

Details of the cross-section stress furnace and transverse loading mechanism were given. The optical system was described in detail. The viscosity data were obtained by a weighted fiber method.

Previous work has suggested that 2 concurrent mechanisms act to relieve stresses in soda-lime commercial glasses in the viscosity range log 12 to log 14.5. These data were represented by an equation of the type:

$$S_t = C_1 e^{\frac{-t}{T_1}} + C_2 e^{\frac{-t}{T_2}} - C_3$$

wherein

S_t = stress level after given soaking time t.

T_1 is a relaxation time for a rapid decaying mechanism

T_2 is a relaxation time for a slow decaying mechanism

C_1, C_2 and C_3 are constants.

The paper also showed stress release and viscosity data on two other types of glasses: namely, a potash-barium glass and a borosilicate. The data indicated that all three types of glass can be represented by similar equations and that the release of stress in glasses is related to their equilibrium temperature viscosities within the annealing zone. The results further indicated that rate of stress release of the soda-lima glass is the same as that for the potash-barium glass. Rates of stress release in the borosilicate glass, however, were slightly slower at comparable viscosities.

A mechanical model was presented, based on the Maxwell-Voight Element, explaining the secondary effects influencing stress release.

Exploration of Lithia Glass Forming Systems: 1. Li_2O-Al_2O_3-SiO_2 with 0 to 30.0 Per Cent CaO Additions by H. W. Rauch; C. H. Commons, Jr.; and H. H. Blau, Foote Mineral Company, Berwyn, Pa., was the final paper of the session. The paper was presented by Dr. Rauch.

Information concerning the use of lithia in commercial glasses has remained limited until comparatively recent times. For many years some lithia has been used in glasses to produce special characteristics such as color or specific absorption effects, certain electrical properties, and desired temperature-viscosity relations.

The scope of the present work was to determine areas of glass formation and to measure properties for some of the glasses developed in the following simple systems:

1. Li_2O-Al_2O_3-SiO_3
2. Li_2O-CaO-Al_2O_3-SiO_2
3. Li_2O-B_2O_3-Al_2O_3-SiO_2

The results of the study indicated that a rather broad area of glasses is possible with the use of lithia. Some of the better areas were as follows:

1. An area of stable glasses exists in the system Li_2O-Al_2O_3-SiO_2 between 7.0 and 22.0 weight per cent lithia, and up to 30.0 weight per cent alumina. These glasses can be made in 100 gram melts and annealed to a strain-free condition. Melting temperatures vary from 2100° F. to 2600° F. depending on composition. Glasses in the high alumina portion of this system are notably fluid. Compositions containing less than 7.0 per cent lithia are extremely viscous and difficult to melt; those containing more than 22.0 per cent lithia devitrify readily.

(*Continued on page* 348)

Spun Glass: Its Genesis and Development

By ALBERT CHRISTIAN REVI, Dallas, Texas

• BY A LENGTHY PROCESS of retrogression we could trace the development of today's fiber glass back to the ancient Egyptian method of decorating glass objects with applied threads of vari-colored glass, but for all practical purposes glass fibers as we know them today were not within the realm of reality until the late eighteenth century or early part of the nineteenth century.

We find in the Memoires de l'Academie des Sciences for the year 1713 this report by the well known physician and naturalist Rene-Antoine de Reaumur (1683-1757): "If they succeed in making glass threads as fine as those of spiders' webs, they will have glass threads of which woven stuffs may be made." Later reports proved Reaumur to be correct.

In a treatise on glass written by the Rev. Dionysius Lardner and dated 1832, the following explanation of the manufacture of glass fibers was found: "It has already been mentioned that glass may be spun into very long and minute threads, with great velocity, when the mass from which it is drawn has been previously heated. For this operation the use of the blowpipe is required, and the manner of its performance is very simple.

"The lump of glass being sufficiently softened by the flame, another piece of glass is applied to it, when the two, cohering together, and being then drawn apart, are seen to be connected by minute filiments. A fine thread being thus obtained, its end is applied to a wheel or reel, and the heat of the glass being maintained, while the wheel is turned with considerable velocity, a thread may be drawn continuously out as long as the workman pleases, or until the store of glass is completely expended.

"The thread thus made is extremely flexible and delicately fine. Its firmness depends in a great measure upon the heat whereat the glass is maintained, and upon the velocity where-with the wheel is turned: the greater these are, the firmer will be the thread.

"Many hundred feet of these filaments may be drawn out from a heated mass in the space of one minute. Its pliancy and elasticity are proved by the facility with which, when in the state just mentioned, it may be bent and retained in various forms, and by the energy wherewith its original shape is resumed at the moment of release from its constrained position."

In those early years glass was treated in this manner in order to afford a pleasing exemplification of some of its properties, or for purposes of ornament. When it was desired to produce colored threads, the glass employed was embued with a very deep tint, for, when drawn out in such minute filaments, it would otherwise appear nearly colorless.

Experiments with glass fibers were carried out with hollow tubes of glass early in the nineteenth century. In the Dictionnaire Technologique des Arts (Vol. xxii, page 216) we find the following account of such experiments conducted by Messr. Deacher. "When a hollow tube of glass is drawn out, the hole remains, whatever may be the fineness of the thread. M. Deacher took a piece of thermometer tube, the interior diameter of which was very small, and drew it out into threads. The drum which he employed was three feet in circumference, and as it turned round five hundred times in a minute, 30,000 yards of thread were obtained in an hour, so that the thread was extremely fine, and its interior diameter scarcely calculable. This thread was, however, hollow, for being cut into pieces of an inch and a half in length, and placed in the receiver of an air-pump, with one end inside and the other out, it allowed the mercury to pass in small shining filaments as soon as a vacuum was made."

At the universal exhibition of 1855 was exhibited the animal group shown in the photograph reproduced on the cover of this issue. It is a life-size representation of a lion, with splendid hair and bristling mane, stifling a serpent. The skin and hair of both serpent and lion are made of glass fibers. This group was the result of thirty years labor by its maker, Messr. Lambourg. It was placed on permanent exhibition in the glass room at the Conservatoire des Arts et Metiers at Paris in 1862. The Dictionnaire des Arts et Manufactures speaks thus of this group and its author. "A very clever enameller (lamp worker) of Saumur has made an extremely interesting application of threads of spun glass, using it to imitate the hair of animals. He assimilates the colors to those of natural skins, and after having cut the threads of a suitable length, he attaches them by one end on a solid surface, copying the arrangement of the skin he wishes to imitate. I have seen at his house tigers, striped hyenas, and other animals of natural size, admirably modelled and covered with the glass hair of which we speak.

"The imitation is so perfect, that these animals might advantageously replace the stuffed skins, always injured, which encumber our museums".

In the mid-nineteenth century one writer reports that the glittering dresses that were formerly worn were made of silk and glass threads woven together. The aigrets also, which adorned ladies' bonnets, and were so fine and flexible that the slightest breeze agitated them, were of spun glass. The flowing black curls, which, when worn by a prince, became the admiration of all Paris, were likewise made of spun glass, curled with irons.

In the Viennese newspaper "Hevrnhut" dated January 23, 1879 we found this account on "Glass Clothing" by Herman Frueauff: "At Gudenfrei, the artist and glass-spinner, A. Prengel of Vienna, has established his glass business, offering carpets, cuffs, collars, veils, etc., of glass. He not only spins, but also weaves glass before the eyes of the people. The otherwise brittle glass he changes into pliable threads and uses them for making good warm clothing. It sounds like a myth, but Mr. Prengel introduces certain ingredients, which are his secret, and thereby changes the nature of the glass. He has just finished a white curly glass muff for a lady in St. Petersburg; he also charges 40 Thalers ($30.00 U.S.

at that time) for them. Also ladies' hats of glass, with glass feathers. A remarkable feature of this glass material is that it is lighter than feathers. Wool made of glass cannot be distinguished from the genuine article. Mr. Prengel's glass inventions are something so extraordinary and useful for clothing, etc., as glass is a nonconductor, that it will probably cause an entire revolution in dress material."

The following account appeared in a San Francisco newspaper dated February 10th, 1879: "There is now weaving in this city the most wonderful fabric of which the voluminous history of unique feminine apparel furnishes any account. It is the material (as flexible as the finest of silk and as durable as Blue Jeans Williams' favourite stuff for trousers) for a lady's dress, and it is woven by the world-renowned artist in glasswork, Prof. Theodore Grenier, out of innumerable colored strands of glass first spun by himself. Compared with the completed

Fig. 1. Dress and parasol made of spun glass threads woven into a fabric by the Libby Glass Company, 1893.

garment, the mythical glass slipper of the famous Cinderella will sink into as vulgar an insignificance as an exhausted soda-water bottle. This reporter called on him recently, and he very courteously showed him the entire process. Breaking an extra piece out of the soiled bottom of an already broken tumbler, he submitted it to the heat of a blowpipe until it became incandescent and soft. Then with a 'stick' of glass he touched the molten portion, and with an expert motion which may be described as a flip, he carried a thread so fine that it was almost invisible till it caught on the disc of a slowly revolving wide wooden wheel of nineteen feet circumference. At a certain number of revolutions the strand was complete, and the wheel was stopped, and it was removed. It then consisted of innumerable softly-glistening threads, finer than the finest of floss silk. These strands are spun of all colors, and are then washed in a solution of water and beet-root sugar, which toughens them. The spinning is all done, and occupied many weeks. The weaving is done on a old-fashioned hand-loom, the warp being nineteen feet long and the woof four feet, so that the material will cut to advantage. Only about ten inches a day can be woven, and the whole piece will not be completed until some time in April."

In the Crockery & Glass Journal dated July 22, 1879 there was quite a lengthy article on the use of glass fibers for weaving dress fabrics. It was obviously written with tongue in cheek for it went something like this: "Pull back dresses will be abolished for the necessity of pulling them back will not exist when even a greater display can be produced without it. Colored ladies will be dressed in mourning the year round. The principles of refraction will be used to overcome figure defects. These same principles will be used in shoes to make large feet small—". In spite of these obvious hazards glass dresses were most certainly made and for no less personages than a famous actress and a Spanish princess.

In a tiny book published by the Libbey Glass Company in 1899, Kate Field gave an interesting account of how the famous actress Georgia Cayvan obtained her glass dress. Briefly, it came about in this way. Miss Cayvan attended the Libbey Glass Company's exhibit at the World Columbian Exposition of 1893 and saw there lampshades covered with a silk-like material woven from glass threads. She asked the Libbey Glass Company if they would weave enough of this material for a dress. They agreed on a price of $25.00 per yard for the goods and Miss Cayvan was given the exclusive right to wear such material on the stage. Libbey sent one of their young women to New York to make the dress for the actress as the material proved too prickly for her regular seamstress to handle. Miss Cayvan wore the gown in the first act of Daniel Frohman's play "The Wife". It would be safe to assume that the dress was not the most comfortable Miss Cayvan had ever worn for the nettlesome material was not as supple as silk or cotton.

Another dress of this same material was made and placed on view in the Libbey exhibition building (see Fig. 1) where it was seen by the Infanta Eulalia of Spain. The princess was fascinated by the glass dress and before she returned to Spain she had a similar gown in her wardrobe.

Most of us can remember with sweet nostalgia the beautiful Christmas tree ornaments that delighted us as a child. Birds with spun glass tails and angels with beautiful curls and wings made of fine glass threads. The glass bird with fine spun glass plumage shown in Fig. 2 was a favorite Victorian ornament. More elaborate groups were made, some with as many as 12 birds, all with flowing tails and wings of various colors. The arrangements included glass flowers and foliage, and usually fluffy glass cotton about the base; all were completely covered with what was known as a "French Glass Dome".

Fig. 2. Glass bird with spun glass plumage and spun glass cotton about base. Photograph through the courtesy of Arthur Churchills, London, England.

The industrial uses for spun glass were not overlooked. In an old trade journal dated March 8, 1877 the writer found mention of glass silk being used in Germany and Austria as laboratory filters. The usefulness of glass silk to druggists and chemists was brought to the notice of the French Societe de Pharmacie by Messr. Limousin in 1878. M. Limousin pointed out that the inalterability of the substance was very well suited for filtering acid or alkaline solutions, even concentrated, and various other substances, such as nitrate of silver, albumen, colodion, Fehling's liquor, etc. It afforded great rapidity of flow, with good filtration and did not communicate organic matter to the liquids. It was found to be superior to asbestos fibers as a filtering agent and could also be washed by reuse indefinitely. During the First World War glass fibers were used for insulating material by both sides when asbestos was impossible to obtain. This use was abandoned after the war as too costly.

The more or less primitive method of producing glass fibers continued to be practiced until about 1930. In 1932 Owens-Illinois Glass Company and Corning Glass Works separately began serious experiments towards mass-production of glass fibers with an idea to using it for insulating material; their success is an already well established fact and today there are several producers of glass fibers. The industrial and home uses of glass fabrics and fibers are so well known to those in the industry that they do not need enumeration here. What was, in 1713, a contingent possibility for the savant has since become a reality. Thanks to modern industry, glass is now drawn as fine and flexible as the finest thread of the silkworm.

L.O.F. TO ERECT NEW TOLEDO BUILDING

Directors of the Libbey-Owens-Ford Glass Company have approved proceeding with detailed plans and specifications for the new, modern office building which is to be constructed on property on Madison Avenue, between Michigan and Ontario Streets, Toledo, Ohio, previously acquired by the company, it was recently announced by John D. Biggers, chairman, and George P. MacNichol, Jr., president.

The action by the directors in effect authorizes the architects, Skidmore, Owings & Merrill, of New York, to work up detailed specifications preparatory to contractors' bids. The George A. Fuller Co., New York, will be the general contractor.

The building will be known as the Libbey-Owens-Ford Building. Construction is expected to give impetus to employment in the Toledo area by taking up some of the slack in the building industry.

The Libbey-Owens-Ford Building, to be constructed on the south side of Madison Avenue between Michigan and Ontario Streets, Toledo, Ohio, will be a 14-story "glass tower," dramatizing the company's Toledo-made products.

While no definite announcement was made as to a starting date, Mr. Biggers and Mr. MacNichol concurred that they are "rushing plans for this much needed facility with the hope" that working plans can be completed to begin construction by early fall and have it completed by February, 1960. They explained that the company's more than doubled manufacturing operations in the last 10 years have created a pressing need for additional administrative and sales space. LOF executive offices presently are scattered in three downtown buildings.

The 14-story free-standing building, in the planning stage for a year, will be downtown Toledo's first new major office building in 30 years. It will be of curtain wall construction, dramatizing the company's products—glass and will be air conditioned throughout.

Thickness of a Silver Mirror Film and the Iodine Ring Method

By HARRY FRY, Research and Development Division,
Shatterprufe Safety Glass Company, Ltd., Port Elizabeth, South Africa

• THIS NOTE IS PROMPTED by an article which appeared in THE GLASS INDUSTRY February 1957 entitled "Different Methods for the Determination of the Thickness of the Silver Film" by Sen & Rao.

As very large makers of mirrors we are naturally interested in this subject and have carried out a large number of experiments in this direction over the past years—in particular we have investigated the Iodine Ring method first mentioned by Fizeau. Our technique of using this method is very simple and, unlike Sen & Rao, we have found quite sufficient reliability in it for it to be used as a rapid "on the spot" method of estimating silver film thickness during production. Naturally it cannot be compared for absolute accuracy with direct chemical analysis but we are satisfied that it does give a sufficient indication while production is in hand as to whether the thickness of the mirror film is adequate for a reasonable life to be expected of the mirror. Regular checking by standard chemical analysis is carried out weekly and we have found a remarkable agreement between these figures and the Iodine Ring count.

It is a well known fact that the quality and life of a silver mirror on glass depend to a large extent on the thickness of the metal deposit. The most usual and convenient method of quoting the "thickness" of a silver mirror film is indirect and is given as "milligrams of silver per square foot of mirror". The actual thickness whether given as microns or millionths of an inch is cumbersome and not so readily appreciated as milligrams/square foot. If we assume that the density of silver in the form of a mirror is the same as that of bulk silver, we can then easily convert mgms. per square foot to a direct thickness measurement, but since this is not necessarily a valid assumption, we still prefer to keep to mgms. per square foot when describing a mirror. In our opinion, based on years of experience in making mirrors, a "thickness" of 120 mgms. silver per square foot gives a first class mirror which, when copperplated and suitably painted, will give a great number of years of service. A figure of 100 mgms. per square foot will give a good commercial mirror but it will not last as long as the former. Below 100 mgms. per square foot is considered by us to be unsatisfactory.

The usual "on the spot" method of assessing a mirror is to view it against daylight. If it appears light blue by transmitted light, it is too thin, while anything from from dark blue to opaque is satisfactory. The method is open to abuse by reason of the human frailties of the observer and also variations in the light against which the mirror is viewed. The second objection can, of course, be overcome by using a standard artificial light but this is not always convenient. The method is in any case not sufficiently quantitative and it was this that first prompted us six years ago to investigate the Iodine Ring method. We urgently needed a rapid and reliable method of assessing our mirrors on the spot during production in addition to our regular chemical checking. This was especially necessary to us since our mirrors were made on a continuous conveyor using sets of spray guns, each set being a complete unit in itself. We could not afford to wait even thirty minutes while a rapid volumetric check was made. In that time 400-500 square feet of mirror would have passed the spray guns.

To test the method, sample mirrors were made under production conditions and examined in the laboratory. Samples were ¼ inch glass 12 by 12 inches, i.e. one square foot, and many samples were made using different numbers of sets of spray guns so as to obtain a set or sets of mirrors of increasing thickness of silver film. Each mirror was treated with a small flake of elemental iodine, covered with a lipless beaker to exclude draughts and left for 10 to 20 minutes. At the end of this time, the number of rings was carefully counted and the mirror then dissolved off the glass using pure nitric acid. The silver in this solution was then estimated either volumetrically using the thiocyanate method or gravimetrically by precipitating the silver as silver chloride and weighing this. We use both methods and obtain equal satisfaction from both.

Naturally the face and edges of the mirrors were cleaned before analysis and, in assessing the area of silver mirror, due allowance was made for the area of the silver destroyed by the Iodine Ring test. This was always small in relation to the area of the sample but nevertheless it was taken into account.

Typical results of two separate series are shown in Table A.

Table A

Number of Sets of Spray Guns	Number of Clear Rings Obtained	Analytical figures in Milligrams of Silver per square foot. Series 1	Series 2
3	3	77	80
6	4	126	125
8	5	170	174
10	6	217	223
12	7	284	276
18	8	356	364

No difficulty was experienced with the thicker mirrors —it being very easy to count the rings. The shape of the rings was not always circular as it matched the shape

Table B

Number of sets of Spray Guns	Visual Examination	Number of Rings	Milligrams of Silver per square foot	
			Series 3	Series 4
2	Very transparent—palest blue	2—Clear and distinct	40	42
3	Very transparent—pale blue	3—Third ring only just visible	60	60
4	Transparent—medium blue	3—Clear and distinct	80	82
5	Transparent—dark blue	4—Center ring very faint	97	100
6	Practically opaque	4—Clear and distinct	125	121
7	Opaque	5—Center ring very faint	142	146
8	Opaque	5—Clear and distinct	175	169

of the horizontal projection of the iodine crystal. The rings start developing immediately when the iodine comes into contact with the mirror and even after only one minute, with a little practice, the eye, especially if aided by a hand lens, can decide how many rings are present. The separation between the rings increases with time, and after 10 to 20 minutes, they are very distinct and there is no doubt as to the count even with the naked eye. After this time, there is some deterioration and fuzzing of the edges, but they can still be observed and counted after several hours have elapsed. We have found it preferable to place the iodine crystal directly on the mirror rather than to use the vapor of iodine as in Sen & Rao's method. In addition, as far as the chemical check analysis is concerned, we prefer to use our relatively large samples (square foot) rather than the smaller ones (2 by 3 inches) as used by Sen & Rao.

It should be mentioned here that we have carried out many analyses to check uniformity of our mirrors over a large area and we have never found any serious discrepancy. It may be assumed that a mirror 12 by 12 inches is quite uniform in film thickness over its whole area.

Table A shows that there is a distinct relationship between the number of rings and the film thickness, and, on the basis of these figures, we can say that a mirror developing only three clear rings is too thin, while one developing four rings is satisfactory.

From the point of view of mirror making, we are concerned only with the top part of Table A and so a further set of experiments was carried out in duplicate in which this part of the table was expanded. Typical results are given in Table B.

The fact that the yields from 3 sets of guns in Tables A & B are different is unimportant as the setting of the spray guns was changed between the two sets of experiments. We are concerned only with the relationship between the number of iodine rings and the thickness of silver.

Taking the mean values of the analytical silver figures from Tables A & B and omitting unnecessary data, we may construct the following table.

Table C

Number of Distinct Iodine Rings	Milligrams of Silver per square foot
2	41
3	80
4	124
5	172
6	220
7	280
8	360

The results given in Table B confirm those at the top of Table A and also illustrate an important point noticed during the experiments. There is not a sharp jump between any number of rings and the next. There is some continuity between them, there being an intermediate stage where it is possible to observe the beginning of the formation of the next ring but this ring never develops to a sufficient strength to justify calling it a full and distinct ring. For example in Table B, 5 sets of spray guns give what may be called 4 rings but the fourth central ring is so very faint, and only just visible to the practised observer, that the count cannot really be reckoned as 4 rings. With 6 sets of guns, this fourth ring is properly developed and there is no doubt whatever as to the count. In this connection, a little practice is necessary to decide the count but when the rings are properly developed, there is no ambiguity.

When the figures given in Table C are graphed, the points are seen to lie on a reasonably smooth curve (see Fig. 1) and it is interesting to observe that the intermediate figures in Table B (i.e. those where one ring is not fully developed) when taken as half rings, also lie on the curve almost exactly,

i.e. $2\frac{1}{2}$ rings ... ... 60 mgm./sq. foot
$3\frac{1}{2}$ rings ... ... 99 mgm./sq. foot
$4\frac{1}{2}$ rings ... ... 144 mgm./sq. foot

To summarize therefore, the Iodine Ring test will give a clear and rapid indication as to whether or not a silver mirror film is thick enough. It is actually sufficiently

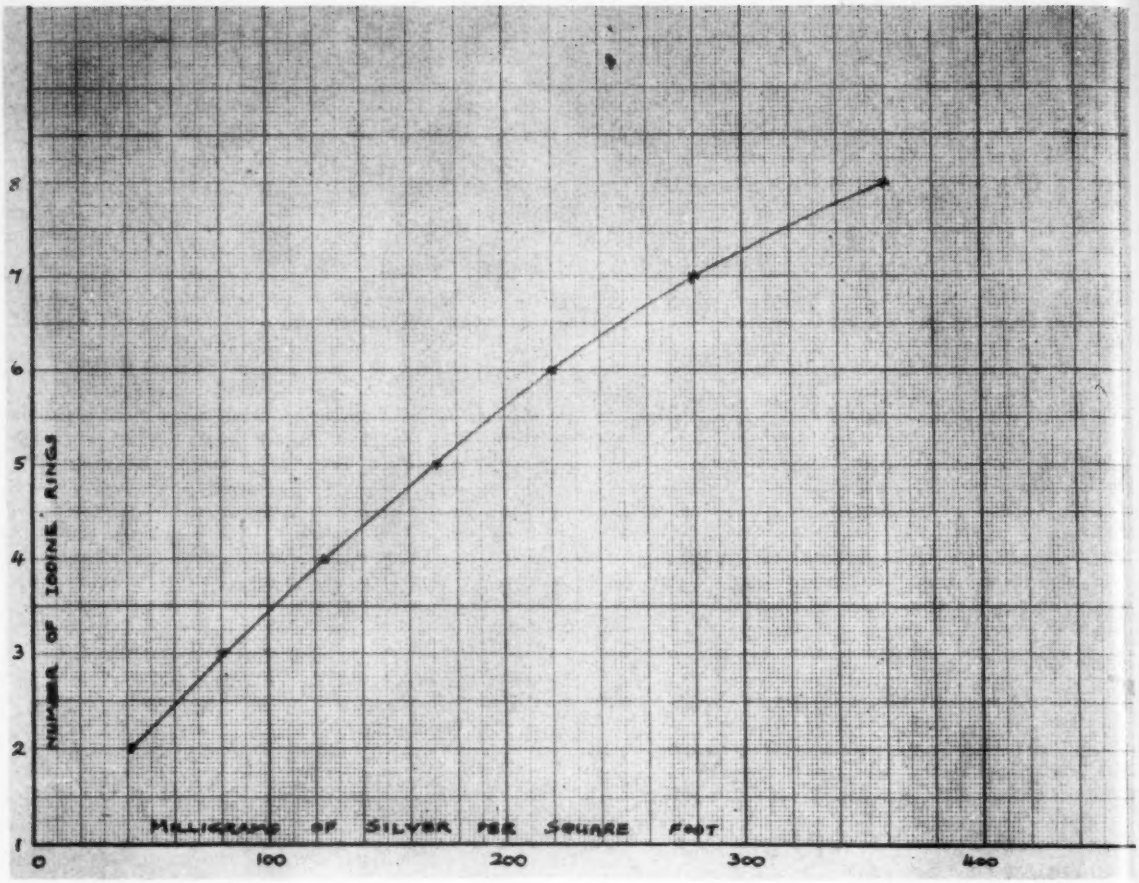


Fig. 1

quantitative to give the "thickness" over a wide range. To carry out the test, the dry mirror is placed on a reasonably level surface in a draught free area and a small crystal of iodine 2 to 3 mms. long placed directly on the silver. This is then covered with a beaker (about 1000 ml. and preferably lipless) to protect it from further draughts and left. When the formation of fresh rings has ceased and the separation of them is sufficient for easy counting—about 10 to 20 minutes—the beaker is removed and the number of rings counted using a small hand magnifier if necessary. A count of four or more perfectly distinct rings is a sure indication that the mirror is thick enough to have a good commercial life. A count of four rings with the center ring hazy and uncertain indicates a borderline passable mirror, while a count of three rings shows a mirror of inferior quality.

For thicker experimental mirrors, we have carried the method to a count of eight clear rings, this indicating a silver "thickness" of 360 mgms./sq. foot or three times what we consider necessary to give a first class mirror.

As a matter of economy, a single small piece of iodine may be used over and over again until it is all volatilized.

T. M. WARE ELECTED PRESIDENT OF INT. MIN. & CHEM.

The board of directors of International Minerals & Chemical Corporation has announced the election of Thomas M. Ware as president.

At 39, the former administrative vice-president becomes the fifth and youngest president of the 50-year-old corporation. He succeeds his father, Louis Ware, who was elected chairman of the board and chief executive officer.

An engineering graduate of Cornell University, Mr. Ware gained his early engineering experience in the aircraft industry and in World War II served as a staff officer in the Navy's Office of Research. He served briefly, after the war, as a management consultant engineer.

He joined IMC in 1947 as industrial engineer and in the next five years, a period of major company expansion, directed construction of new plant facilities and installations as chief engineer. Elected vice-president of engineering, he planned, coordinated and directed a program that streamlined methods in IMC's 72 mines and plants throughout the country.

Since 1955, as administrative vice-president, he has centralized and broadened the corporation's staff services including engineering, marketing, purchasing, traffic and mining and exploration. He was elected to the board of directors in 1957 and has had the additional responsibilities of the executive vice-president since the retirement of James P. Margeson last June.

Summaries of Glass Conference Papers

Automatic Recording and Controlling of Flue Gases, by R. K. Gunsaulus
Practical Application of Flue Gas Analysis to Glass Melting Furnaces, by Paul M. Spatz

AUTOMATIC RECORDING AND CONTROLLING OF FLUE GASES

By R. K. Gunsaulus
Bailey Meter Company, Detroit, Mich.

• WHEN THE CONSTITUENTS of fuel are burned we primarily mix oxygen with carbon and hydrogen. Under the correct conditions of time, temperature, and turbulence we obtain a chemical reaction which produces heat, carbon dioxide, and water. For theoretically perfect combustion the exact amount of oxygen required would have to be combined with all of the fuel at the proper temperature and with sufficient time allowed for the reaction. In practice we cannot obtain this perfect combustion because of many factors; therefore, excess air is usually supplied to assure complete combustion of the fuel. A measurement of oxygen in the products of combustion will give the excess air; while a measurement for unburned combustibles will give the amount of air deficiency.

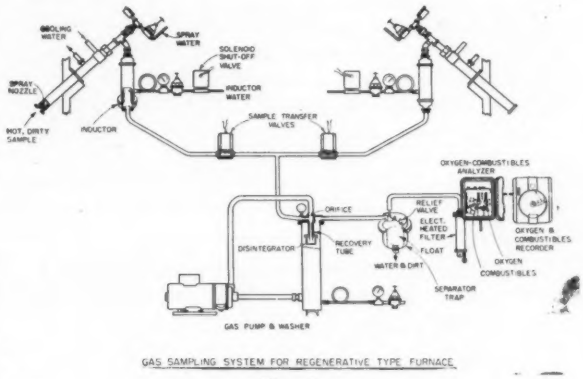
Both conditions, excess oxygen and excess combustibles, represent a loss in heat which, in turn, reflects itself in more fuel being required to hold melting temperatures. But of more importance, an undetected variation in combustion will change the heat input to the process, upsetting the desirable steady state condition.

A logical question could be "How is a gas sample obtained on a glass furnace and how is the gas analyzed for the two constituents, oxygen and combustibles?"

One analyzing method utilizes the catalytic combustion principle where the unknown gas sample is combined with a standard fuel for oxygen measurement and with air for combustibles measurement. The resulting mixture is burned and the temperature of combustion is directly proportional to the percentage of oxygen or combustibles in the unknown gas. This is the same principle as used in the portable heat prover gas analyzer.

In a typical two-point sampling system as used on a regenerative type glass tank, (Fig. 1) the hot, dirty gas sample enters through a water spray at the end of the water-cooled, water-washed sample tube. The spray prevents most of the dirt or carryover from entering the sampling system, while the water-cooled outer jacket keeps the tube from being overheated. Water sprayed tangentially into the inductor thoroughly submerges the gas sample in water, cools the sample, and keeps the sample lines from plugging by dust and dirt. In the gas pump and washer, water from the pump jets through an orifice. The resulting vacuum pulls the sample from the sample line. In the disintegrator cup the direction of flow is twice reversed to thoroughly mix the sample and water and to wet the dust and dirt particles. The sample-entrained water-dirt mixture is then introduced tangentially into the separator trap where the water and dirt mixture are thrown to the outside and then go to the drain through the float-operated valve. The cleaned and cooled gases leave at the top of the separator and go to the heated filter assembly. The heated filter assembly assures a clean, moisture-free sample to the analyzer. The gases are analyzed by the catalytic combustion principle and the per cent by volume of oxygen and combustibles is recorded on the same chart by a two-pen recorder.

The results from the application of the gas analyzer to the glass furnace process have been very rewarding. Invariably a very substantial fuel saving has resulted. On one installation, furnace pressure and oxygen control were installed about a year after the furnace was rebuilt. A fuel saving of 6 per cent to 8 per cent resulted, and the entire savings could be attributed directly to the improved operation as a result of stable control of the furnace pressure and oxygen.



GAS SAMPLING SYSTEM FOR REGENERATIVE TYPE FURNACE

Fig. 1

Another benefit derived is the uniform temperature resulting from constant combustion conditions. Also the glass quality can be expected to improve as the melting temperatures are held more constant. This eliminates one very important variable in the overall operation of a glass tank, and other variables can then be better studied to make further improvements.

Furnace life, as a result of better combustion control, is also extended; this results in more production time and less repair time.

Because less heat is wasted, more Btu's are available for glass melting, and added glass melting capacity, from the same furnace and auxiliary equipment, is available.

On furnaces that utilize two or more fuels, the gas analyzer is most beneficial because excess air measurements by oxygen is the same regardless of the fuel

used. The furnace is much easier and more quickly stabilized following a change of fuels, thereby holding production quality more constant.

The permanent record provided serves as a continuous operating guide to the operator and shows a minimum of eight hours of furnace performance history. It also provides a continuing check on performance for supervisory personnel, and is useful in trouble-shooting as it can, many times, pinpoint the trouble, or eliminate some of the variables.

An important factor in the successful application of recording and controlling the flue gases on a glass furnace is the ability of the sample system to handle continually hot, dirty gases, and deliver a clean, dry sample to the analyzer. The analyzer-sampling system response must be fast to enable it to control, because current measurements, not past history, are required to check continuously the dynamic combustion process.

A high initial and sustained accuracy must be maintained with a minimum of maintenance and checking. The gas analyzer, by its very function of handling a corrosive, dirty sample requires somewhat more maintenance attention than a temperature recorder or a flow meter. However, this maintenance is mainly routine checking to assure proper operation of the sample system and analyzing equipment.

If for only one reason, a continuous gas analyzer can be justified on a glass furnace because of the fuel saving to be realized. Actual payout of the equipment plus installation cost can be realized on most glass furnaces in less than one year; on some the payout can be made in six months time. This means a saving equaling the installed equipment cost every six months, which is an item that cannot be overlooked in these days of high and rising fuel costs.

This of course, is a tangible result than can readily be determined and proved. Many other related benefits, which are more difficult to evaluate, have been demonstrated and can be derived by automatically recording and controlling the flue gases.

PRACTICAL APPLICATION OF FLUE GAS ANALYSIS TO GLASS MELTING FURNACES

By Paul M. Spatz, Plant Engineer,

Diamond Glass Company, Royersford, Pa.

• FLUE GAS ANALYSIS IS briefly the science of determining air-fuel ratio and the degree of completeness of combustion from analysis of three major products of combustion, carbon dioxide (CO_2), oxygen (O_2), and combustibles mainly in the form of carbon monoxide (CO). The subject of the chemistry of fuels, and the technical discussion of combustion is deep and interesting, and many excellent papers, books and opinions are available on the matter.

From the viewpoint of the engineer in charge of the glass melting furnace, however, much of the theoretical and technical must be by-passed or sacrificed in order to overcome the seeming mysteries of each individual furnace for practical operation. Generally speaking there are some hard and fast rules that can be applied that should secure good combustion in most furnaces. Much benefit is derived from proper flame geometry, color, contact with bath, clearance from refractories, etc. that cannot be defined or made interchangeable from one furnace to another. Each operator, through experience, must determine what is best and most suitable for his fuel, furnace, draft and so forth.

Many different types of instruments are available for the analysis of flue gases. Most instruments indicate the percentages by volume of the various components in the flue gas. Perhaps the most common of these instruments is the orsat, which works on the principal of selective absorption of the gases by chemical solutions. Several analyzers are available today operating on principals that seem to have equal merit. The catalytic combustion, conductivity and magnetic systems and others are proving their ability to indicate the percentages of O_2 and combustibles contained in flue gases. Each instrument has a degree of repeatability that seems acceptable to most furnace operators.

The manual orsat is the more precise instrument for furnace work but its operation is quite time consuming because of the very large number of locations on the furnace that require checking. If pressed with other duties the furnace engineer may tend to skip some locations if his initial analysis looks okay. It is not humanly possible to take enough orsats during a given time interval to be sure of the maximum and minimum combustion conditions at a particular location in the furnace.

For these reasons the portable automatic oxygen and combustibles analyzer may prove invaluable to the furnace engineer. With such an apparatus it is possible continuously to analyze flue gases at each furnace location for a long enough period of time to observe any combustion cycle that may be taking place.

The finest gas analyzer will give poor and non-repetitive results if not associated with a sound gas sampling means. As has been well stated by the experts: "No analyzer can be any better than its sampling system". The sample system must be able to deliver to the analyzer a gas sample that is free from dirt, dust, corrosive gas and excessive water vapor, and in the shortest possible time, or "rate of response". The sample line should be permanent and operate with a minimum of maintenance. Many means are used to accomplish the desired end; some are inspirators, aspirators, centrifugal pumps, water washers, cyclones, electrostatic precipitators and so forth. It is the duty of the furnace engineer to investigate thoroughly the gas sampling system and choose the one best suited to his needs.

Even the simple orsat should use a well designed sample system. While filters and washers and pumps are not used with the orsat apparatus, a good furnace sampling tube is necessary. The engineer must be certain his tube is long enough to draw a representative sample and that parasite air is blocked from the point of sampling. One can be reasonably sure that parasite air is excluded if the furnace is under a minimum positive pressure of .02" H_2O and a slight stingout is visible at the point of sampling. A good tight fit at the peephole cover or other point of sampling is important.

Good combustion conditions consistently maintained in the glass melting furnace should be conducive to:

Good fuel economy;

Maximum furnace pull;

Minimum deterioration of refractories in the superstructure, particularly in the ports and upper regenerators;
Control of blisters;
Control of glass color (particularly so in multi-burner direct fired furnaces);
Proper flame gometry (pattern).

It is difficult to lay down hard and fast rules to cover all furnaces and their optimum combustion operation. There are, however no end of tables showing the cost in money for various percentages of excess and insufficient air for combustion. Both primary and secondary air must be carefully adjusted for proper burner operation. The burner manufacturer is usually quite specific on these operating conditions and in most cases it is well to adhere to his instructions.

By rule of thumb, 10 per cent excess air is equivalent to 1 per cent fuel waste which equals about 5 cents per ton of glass melted. An air deficiency of 10 per cent can mean a 10 per cent or greater loss of fuel through combustible loss in the exit gases. Moneywise this is 10 times the loss resulting from excess air, plus all the other damage caused by a combustible atmosphere.

Maximum furnace pull is dependent upon good combustion and proper heat distribution throughout the melting chamber. For maximum refractory life, combustibles, particularly CO, must be kept at a minimum; upper regenerators and port necks soon deteriorate in heavy combustible atmospheres. A combustible atmosphere is conducive to blister formation. Prolonged CO concentration of 1 per cent and above in the forehearth side of the bridgewall will almost always result in a high blister count.

Flint glass color is readily affected by a prolonged concentration of CO in the combustion gas. In a 6 by 36 foot direct fired furnace it was possible to move from very high to very low color flint in a matter of 6 to 8 hours by changing the furnace combustion from a lean of 2 per cent O_2 to a rich 1 per cent CO. By calculation and chart 2 per cent O_2 equals about 10 per cent excess air and 1 per cent CO equals about 0.4 per cent combustibles.

Proper combustion is a must for good flame pattern. A high velocity dazzling white fire is hard to hold and control as is a very slow high radiant lazy flame. Flame contact with the glass batch is important (for a reason or reasons not too well explained as yet), and if at all possible should be maintained. A short bushy fire will tend to gather a layer of combustion gas between itself and the surface of the glass bath possibly insulating the latter to some degree.

In review of these few points then, to apply practicable flue gas analysis to the glass melting furnace the engineer will be sure he has:

1. a good sample system designed for his furnace;
2. a sound analyzing device either intermittant or continuous;
3. selected representative points throughout the furnace for complete combustion analysis; and
4. proper visual records to give a picture of the entire furnace, combustion and temperature-wise.

With these conditions tied down the engineer can then begin to interpret his combustion results. For good combustion the outgoing ports should show a minimum of excess air and combustibles to reduce to a minimum the gas losses. This should be accomplished by adjusting primary air at each port for flame pattern and horizontal temperature gradient.

Total combustion air supply should then be set to average the required excess air from each outgoing port. The flues and valve should be kept in good enough repair to limit parasite air to a maximum of 2 per cent as measured in oxygen (O_2). An aid to reduce the entrance of parasite air in the flue is to coat the entire regenerator outside walls from the port floor to the base with boiler seal compound.

L.O.F. GLASS FIBERS NAMES J. M. KEENAN GENERAL FACTORIES MANAGER

John M. Keenan has been named general factories manager of L.O.F. Glass Fibers Company, it is announced by Thomas A. Collins, vice president and general manager of the firm's eastern division. He succeeds J. H. Plummer who has resigned.

J. M. Keenan

Prior to entering the glass business, Mr. Keenan was in the industrial engineering departments of the Textileather Corporation and North Star Woolen Mills. He was in the U. S. Army for 3½ years in World War II. A native of Minneapolis, he attended the University of Minnesota.

In his new assignment, Mr. Keenan will have full supervision of all eastern division plants. Three are located in Defiance, Ohio with other plants in Waterville, Ohio and Parkersburg, West Virginia. Mr. Keenan was formerly manager of the Parkersburg plant.

He has been allied with the glass industry since 1950 when he joined Glass Fibers, Inc. as an industrial engineer. He was named manager of the Waterville, Ohio plant in 1953 and continued in that capacity following the merger of Glass Fibers, Inc., with the Fiber Glass and Corrulux Divisions of Libbey-Owens-Ford Glass Company in 1955 to form L.O.F. Glass Fibers. In March 1956 he was appointed manager at Parkersburg.

L.O.F. GLASS FIBERS PROMOTES T. A. KIGER

Thomas A. Kiger has been assigned as an engineer in the product planning department of L. O. F. Glass Fibers Company, it is announced by Hugh W. Paul, product planning department manager.

Mr. Kiger has been associated with the company since 1947 advancing from a foreman to shift supervisor and finally becoming a department manager in the textile division.

A native of Holland, Ohio, he served two years with the Navy and is a member of the Springfield Township volunteer fire department. He and his family live on Dunn Drive in Holland.

NEW EXECUTIVES ELECTED AT BROCKWAY

Brockway Glass Company has announced the election of G. A. Mengle as chairman of the board and chief executive officer of the company on the occasion of the election of Finley B. Hess to the post of president. Mr. Mengle has been president of the company since October 1, 1949, and also served as chairman since November 1954, following the retirement of Robert L. Warren, Sr., who had served as president and chairman.

G. A. Mengle

F. B. Hess

Mr. Mengle will remain active and will now be in a position to devote himself to overall company policy and particularly to matters of growth and expansion. "Business," he stated, "with our present facilities is quite good and we expect to increase it greatly. Our Freehold plant, for example, is only now coming into its own. Our subsidiary, the Demuth Glass Works, is being developed to provide us with a more complete diversification."

Mr. Hess is advancing from the post of executive vice president, which he has held since 1954. A cum laude graduate of the University of Pennsylvania's Wharton School, he joined Brockway in 1933 when the company he was then with, Monaca Glass, was taken over by Brockway. He was made vice president in charge of manufacturing early in the 1940's and held that position until becoming executive vice president in November, 1954. Active in industry groups, he is on the Government Industry Relations Committee of the Glass Container Manufacturers Institute, Inc., and is vice president of the Glass Container Industry Manufacturer's Research Corporation.

Mr. Mengle was president of Brockway Sales Company when that organization merged with Brockway Machine Bottle Company in 1933. From that time until July, 1944, he served as vice president and general sales manager of Brockway Glass Company. He remained at that post until 1949 when he was elected president of the firm. He is a trustee of the Glass Container Manufacturer's Institute, a director of the Brewer's Foundation, director of the DuBois Deposit National Bank, and a member of the Regional Executive Committee of the Boy Scouts. In addition to his stature in the glass industry, Mr. Mengle is a nationally known breeder of Aberdeen Angus Cattle. He is a past president of the Pennsylvania Aberdeen Angus Association.

ALFRED U. RECEIVES GRANT FROM LEAD INDUSTRIES ASSOCIATION

The Lead Industries Association has given the State University of New York College of Ceramics at Alfred University a $3,000 grant for research on the use of lead in glass.

Charles H. Greene, Chairman of the Department of Glass Technology, said that the funds will be used to study the effect of lead on the physical properties of various compositions of glass. He said a graduate research student will work on the project during the coming year, making laboratory samples and measuring their properties.

"It is felt that the more that is known about the effects of lead in glass, the more lead will be used in the manufacture of glass" Dr. Greene explained.

Three properties of glass which are known to vary with lead content are brilliance or refractive index, softness, and electrical insulation, Greene said. Glass with a high lead content is used in the section of bifocals needed for close work because it bends light more than glass with a low lead content, he explained. High lead content makes glass a better electrical insulator, and lead is an important element in glass that needs to be melted easily for use in decoration on other glass or pottery products, he added.

CORNING AND CORHART REFRACTORIES TO CONSOLIDATE DEPARTMENTS

Consolidation of the refractories sales, product promotion and product engineering departments of Corning Glass Works and Corhart Refractories Company, Inc., was announced recently by Edward C. Leibig, Corhart president.

J. D. Pisula

J. Donald Pisula, formerly manager of the Corning refractory sales department, has been appointed manager of refractories marketing for the consolidated staff.

Corhart, a wholly owned subsidiary of Corning Glass Works, manufactures Electrocast refractories for glass-making furnaces and special refractories for the steel industry. Corning produces conventional glass tank refractories and special high temperature refractories, including Glascast mold materials for precision metal casting.

Corning personnel who will now operate from the Corhart offices at 940 Commonwealth Building in Louisville include Mr. Pisula, Edmond M. Baker, F. David Elliott, Paul V. Lovette Jr. and Joachim H. P. Pohle.

Mr. Pisula has been associated with Corning since 1944 when he joined the Technical Products Division sales staff. He has been manager of refractory sales since 1952.

A native of Uniontown, Penna., Mr. Pisula was graduated from Pennsylvania State University in 1941. He had been associated with the U. S. Steel Corporation, Joy Manufacturing Company and Bendix Aviation Company prior to joining Corning.

Inventions and Inventors

Annealing and Tempering

Method of Applying a Light-Diffusing Layer to a Glass Surface. Patent No. 2,798,007. Filed June 25, 1954. Issued July 2, 1957. Assigned to North American Philips Company, Inc., by Gerardus Hendricus Janssen and Petrus Cornelis van der Linden.

A method of applying a light-diffusing layer to a glass surface comprising the steps, contacting the glass surface with a gaseous oxidation product of sulfur obtained by burning a sulfur containing substance, and precipitating on the so-treated surface an oxide of magnesium obtained by the combustion of magnesium.

There were 10 claims cited in this patent.

Feeding and Forming

Means and Method of Heat-Joining Glass Articles. Patent No. 2,796,313. Filed May 1, 1956. Issued June 18, 1957. Two sheets of drawings; none reproduced. Assigned to American Optical Company by Elmer Weldon Schumacher.

This invention relates to improvements in devices for heat-joining parts of glass articles.

One of the principal objects of the invention is a novel machine provided for automatically supporting glass parts to be joined initially in aligned spaced relation with each other, pre-heating said parts to avoid heat shock, moving said parts into proper fitted relation with each other and thereafter heat-sealing said parts together.

There were 10 claims and the following references cited in this patent: 2,259,165, Karasick, Oct. 14, 1941; 2,645,059, Rowe, July 14, 1953; and 989,714, France, Sept. 12, 1951.

Production of Free-Flowing Glass Beads. Patent No. 2,794,301. Filed January 29, 1953. Issued June 4, 1957. One sheet of drawings; none reproduced. Assigned to Flex-O-Lite Manufacturing Corporation by Preston D. Law and Vincent L. Duval d'Adrian.

This invention relates to the production of glass beads and in particular is concerned with the manufacture of spherical glass beads of small particle size which have a free-flowing characteristic when stored together.

It has been found possible to incorporate in the method for production of these spherical glass beads a process which constitutes contacting the glass with strong acidic gases which react with the alkali so as to form an alkali salt which does not absorb moisture. These acidic gases may be charged directly to the glass material as it is in the process of being heated at the high temperatures involved; or certain compounds may be introduced with the glass charge which liberate acidic gases upon being subjected to the high temperatures encountered in the process. In general, the acidic gases contemplated are those which form strong acid salts with sodium and includes chlorine, sulphur dioxide, sulphur trioxide, the various oxide gases of nitrogen, as well as the corresponding acids, such as hydrochloric acid, nitric acid and sulphuric acid, which volatilize at the temperatures encountered. The solid compounds which may be introduced in the glass charge include sulphur, ammonium nitrate, and other compounds which liberate the desired acidic gases at the temperatures utilized. By utilizing the process of this invention it is made possible to produce, without the requirement of any additional steps after the production of these glass beads, free-flowing glass beads which are covered with an inert layer and have improved reflecting qualities as well as increased strength over the beads made in the conventional processes previously utilized.

Accordingly, it is a primary object of this invention to obtain glass beads of small particle size which have a free-flowing characteristic under normal atmospheric conditions, and are not subject to agglomeration.

There were seven claims and the following references cited in this patent: 1,782,169, Kamita, Nov. 18, 1930; 2,038,251, Vogt, Apr. 21, 1936; 2,241,511, Greene, May 13, 1941; 2,331,944, Pazsiczky et al., Oct. 19, 1943; 2,334,578, Potters, Nov. 16, 1943; 2,461,841, Nordberg, Feb. 15, 1949; 2,500,801, Church, Mar. 14, 1950; and 2,713,286 Taylor, July 19, 1955.

Furnaces

Glass Furnace. Patent No. 2,794,058. Filed August 14, 1952. Issued May 28, 1957. Four sheets of drawings; none reproduced. Assigned to Owens-Corning Fiberglas Corporation by Robert G. Russell.

The present patent includes the utilization of the feeder as a resistance unit in an electric circuit in order to heat the feeder for maintaining the glass or other molten material in a desired flowable condition. The frame or plate which supports the feeder is also arranged to form a part of the electrical circuit through the feeder.

Formed on the plate is a pair of spaced ridges or projections extending around the central opening accommodating the feeder, the ridges bounding a recess in which is disposed a tube or duct, the inlet and outlet portions of the tube being in juxtaposed relation at one corner of the plate. The tube may be of metal, for example, copper, and is adapted to contain a fluid for circulation to reduce the temperature of the plate in order to avoid distortion or warping of the plate under the high temperatures which exist at the feeder.

The tube may be utilized for the circulation of any suitable fluid such, for example, as water, air, steam or other fluid having satisfactory heat-absorption characteristics for conducting heat away from the plate at a rate which will prevent distortion or warping. The temperature of the fluid circulating through the duct is lower than the fusing temperature of the glass or other fiber-forming material which causes the glass disposed between the floor of the tank and the plate or frame at the zone of the tube to congeal or freeze and thus establish a seal of solid glass or material between the plate and the floor of the tank. If the seal should be disrupted or broken, molten glass or material from the tank will flow into the

rupture immediately, and the reduced temperature in the zone of the tube will cause the glass to congeal and automatically restore the seal.

In addition to a resistance-heating unit for melting the glass batch or other fiber-forming material, it is desirable to control effectively the temperature of the flowable material in the zone of the feeder in order to obtain the flow of streams of uniform size and viscosity through the feeder orifices so that the fibers attenuated from the streams will be of uniform character.

There were 11 claims and the following references cited in this patent: 1,610,377, Hitner, Dec. 14, 1926; 2,165,318, Thomas et al., July 11, 1939; 2,189,822, Thomas et al., Feb. 13, 1940; 2,215,982, Slayter et al., Sept. 24, 1940; 2,219,346, Thomas et al., Oct. 29, 1940; 2,257,767, Slayter et al., Oct. 7, 1941; and 2,692,296, De piolenc et al., Oct. 19, 1954.

Glass Compositions

High-Index Glass Elements. Patent No. 2,790,723. Filed August 12, 1953. Issued April 30, 1957. No drawings. Assigned to Minnesota Mining & Manufacturing Company by Norman H. Stradley and Warren R. Beck.

This invention relates to transparent high-index glass elements, such as glass beads, fibers, flakes and thin plates.

The beads can be made by fusing particles of glass cullet which are blown or dropped through a high temperature flame or a radiant heating zone to soften them sufficiently to form transparent spheres by the action of surface tension while moving through air followed by rapid cooling to harden the spheres without devitrification taking place. The cullet can be made by quenching a stream of molten glass in water. The beads can also be made directly from a batch of molten glass.

Fibers can be made by jet-blowing a stream of molten glass. Filaments can be drawn from molten glass through a die, followed by rapid cooling. Thin plates and flakes of glass can be made by casting a thin layer of molten glass on a cold steel surface. Many of the glasses have been tested in the form of thin plates and have been found to have dielectric constants up to about 60, indicating suitability for use as dielectric elements of capacitors, etc.

The glass compositions which are employed may be generically defined as being those having refractive index (n_d) values of at least 2.1 and essentially consisting of metal oxide combinations designated in the following table, proportions being in percentage by weight:

TiO_2	20-50
PbO	10-65
BaO Group	0-45
ZnO	0-10
CdO	0-20
Bi_2O_3	0-5
PbO+ZnO+BaO Group	35-80
CdO+ZnO+BaO Group	5-45
PbO+CdO+Bi_2O_3	10-70

The preferred glasses may be referred to as being of the TiO_2-PbO-BaO type and, consistent with the limitations previously stated, contain approximately 25 to 45 per cent TiO_2, 15 to 55 per cent PbO, 5 to 35 per cent BaO, 1 to 8 per cent ZnO, and 1 to 6 per cent (total) of one or more strong glass-forming oxides (B_2O_3, SiO_2, P_2O_5 and GeO_2), proportioned so that the total of PbO, BaO and ZnO is at least approximately 50 per cent; the glasses consisting substantially entirely of these oxides and having refractive indices of at least 2.15.

There were six claims and the following reference cited in this patent: 2,220,765, Hirose et al., Nov. 5, 1940.

Glass Wool and Fiber

Article of Manufacture and Method and Apparatus for Producing Same. Patent No. 2,785,728. Filed Nov. 23, 1953. Issued Mar. 19, 1957. 19 pages of drawings; none reproduced. Assigned to Owens-Corning Fiberglas Corporation by Games Slayter, Henry J. Snow and Samuel D. Philipps.

The present invention embraces a method and apparatus for producing fibrous mats or assemblies wherein the cost of fabrication is greatly reduced and the insulating value or efficiency of the produce improved over prior fibrous mat constructions.

An object of the invention resides in a method and apparatus for forming a relatively thin veil, web or stratum of attenuated fibers folded or lapped upon itself to form a mat in a manner eliminating the projection of individual fibers from one major face of the mat to the other.

The method of the invention embraces the steps of forming fibers of mineral material and collecting them in individual layers or webs which are caused to be brought into contiguous relation to form a relatively thin layer or veil of a laminated character in which the fibers of one layer do not extend or project through to the outer surface of the other layer; the insulation factor is greatly improved over prior fibrous insulating units.

An object of the invention resides in a method of forming and collecting masses of mineral fibers in spaced zones, bringing these masses into contiguous relation and applying a binding material in such a manner that the material is distributed through the contiguous layers of fibers thus augmenting the insulating efficiency by reason of the uniform distribution of binding material in and throughout the layers of fibers.

There were 33 claims and 14 references cited in this patent.

Glass Paper. Patent No. 2,787,542. Filed March 13, 1952. Issued April 2, 1957. Two sheets of drawings; none reproduced. Assigned to Libbey-Owens-Ford Glass Fibers Company by Dominick Labino.

This invention relates to a new article of manufacture comprising glass paper.

An example of production of glass paper according to the method of this invention, glass was melted in a heating chamber at a temperature of approximately 2650° F. The primary glass fibers were drawn to a diameter from 0.002 to 0.007 of an inch. These primary glass fibers were advanced into a burner flame having a temperature of approximately 3300° F. with a blast velocity of 1600-2000 ft./sec. whereby staple glass fiber of a diameter of 0.04 to 1.0 micron with a length of from ⅛ to ⅜ of an inch was produced.

The staple glass fibers so produced were collected on a wire belt with the dry loose glass fiber being collected on the belt in a mat thickness of about ⅛ of an inch

under suction of 10 to 14 inches of water applied to the under side of the belt in the area on which the fiber is collected. This loose web or mat of glass fibers was wet with a water spray to compact the mat to a thickness of approximately 0.005 of an inch. The compacted web of glass fiber was then heated to drive off excess moisture and while still damp was directed under a light-weight roller.

The paper produced as a result of this method had a thickness of 0.005 of an inch, a density of .22 gr./cc., and a melting point of 1550° F. The paper exhibited a tensile strength in the dry condition of 220 p. s. i. and in the wet condition of 1150 p. s. i. It will be noted that the tensile strength of the paper is considerably greater in the wet condition, approximately five times greater than the dry strength.

The superior characteristics exhibited by paper products according to the method of this invention is considered to be solely the result of uniformity of diameter of glass fibers of micron diameter and less, and uniformity of length of the fibers.

There were two claims and 13 references cited in this patent.

Fiber Reinforced Tubular Article. Patent No. 2,791,241. Filed July 6, 1954. Issued May 7, 1957. One sheet of drawings; none reproduced. Assigned to A. O. Smith Corporation by Daniel J. Reed.

This invention relates to tubular articles and more particularly to fibrous reinforced resin pipe.

The stresses in a pipe due to internal pressure can be resolved into longitudinal and circumferential stresses, and it has been determined that for a given internal pressure the circumferential stress is approximately twice that of the longitudinal stress in a pipe with free ends.

The pipe is wound so that the pattern of winding more nearly coincides with major and minor axes of stress. The invention is directed to a pipe having two separate patterns of winding, one pattern of winding having a helix angle of from 2° to 10° and the other pattern having a helix angle of about 80° to 88°. In addition, the number of fibers laid up with a 2° to 10° helix angle are approximately twice that in number of the fibers wound with a helix angle of 80° to 88°.

With this novel pattern of winding the fibers can more effectively resist internal stresses and there will be a minimum of movement of shifting between the layers of fibers, so that the shear stresses present in the conventionally wound pipe will be virtually eliminated.

There were three claims and the following references cited in this patent: 757,877, Bosch, Apr. 19, 1904; 940,779, Bayne et al., Nov. 23, 1909; 1,951,723, Burd et al., Mar. 20, 1934; 2,467,999, Stephens, Apr. 19, 1949; 2,552,599, Stout, May 15, 1951; 2,614,058, Francis, Oct. 14, 1952; 2,653,887, Slayter, Sept. 29, 1953; and 2,678,-666, Theis et al., May 18, 1954.

Sheet and Plate Glass

Glass Laying Apparatus. Patent No. 2,780,039. Filed May 11, 1954. Issued Feb. 5, 1957. One sheet of drawings; none reproduced. Assigned to Pittsburgh Plate Glass Company by Charles S. Cusick.

This application relates to improvement in glass laying apparatus.

Typical apparatus for the fabrication of polished plate glass includes a conveyor and a plurality of movable tables which are carried along the length of the conveyor in an abutting relationship to provide a continuous elongated surface upon which a plaster slurry is applied.

In the past, rough glass sheets placed upon the tables have been slid against these metallic strips, thus causing vents and chips to appear in the edges of the glass sheets. These chips and vents frequently remained on the surface of the glass and eventually became embedded in the faces of the polishers farther down the grinding and polishing line. These chips abraded the surface of the glass being polished, thereby spoiling the results of the surfacing operations. The cause of such venting and chipping has been eliminated by providing abutting means overlapping the side of the polishing table against which the sheets are slid during laying. This abutting means provides a soft yielding cushion for the edge of the glass sheets and keeps the glass sheets from bumping the edge strip, thereby preventing chips and vents.

There were six claims and the following references cited in this patent: 1,754,955, Kruse, Apr. 15, 1930; 1,934,794, Fisher, Nov. 14, 1933; 2,122,466, Heichert, July 5, 1938; and 2,705,854, Laverdisse, Apr. 12, 1955.

Washer for Bent Laminated Glass. Patent No. 2,781,534. Filed June 24, 1952. Issued February 19, 1957. Four sheets of drawings; none reproduced. Assigned to Pittsburgh Plate Glass Company by Carl J. Cochran and Martin W. Neuhausen.

This invention relates to apparatus for washing articles having curved surfaces, particularly windshield laminations.

An important feature of the invention comprises rotary brushes of substantial width transverse of the direction of movement of the windshields or other work pieces through the apparatus, and these brushes are constructed so that they taper, that is, the diameter of the respective brushes becomes progressively less toward one end. However, the taper of the complementary brushes on opposite side of the windshield are in opposite direction, and the gain in the diameter of one brush is substantially equal to the reduction of the diameter of the other brush. This gives a variety of linear speeds to the bristles of the different regions of the brushes and results in a more satisfactory washing action than with brushes that are of substantially uniform diameter throughout their width.

There were 16 claims and the following references cited in this patent: 2,213,426, Anderson et al., Sept. 3, 1940; 2,293,858, Schafer, Aug. 25, 1942; 2,312,186, Paddock et al., Feb. 23, 1943; 2,506,075, Fleury, May 2, 1950; 2,632,197, Moss et al., Mar. 24, 1953; 2,671,926, Minerley, Mar. 16, 1954; and 403,970, Germany, Oct. 9, 1924.

Process for Surfacing Glass. Fig. 1. Patent No. 2,787,-100. Filed May 20, 1952. Issued April 2, 1957. One sheet of drawings. Assigned to Societe Anonyme des Manufactures des Glaces et Produits Chimiques de Saint-Gobain, Chauny & Cirey by Ivan Peyches.

This invention concerns the continuous process of glass surfacing, i. e. a process where the sheet glass moves at a slow pace along a straight path and is ground and

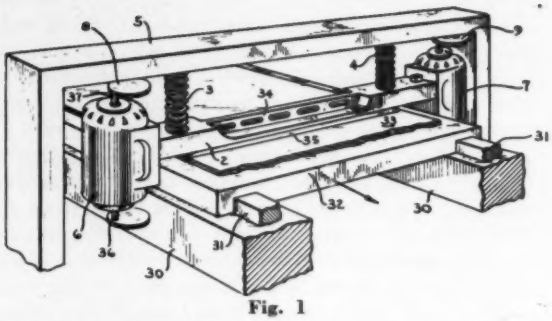


Fig. 1

polished by means of tools arranged one after the other along the path of the glass.

In Fig. 1 the numeral 30 indicates the frame of the machine, upon which are mounted tracks 31, over which moves a bed plate 32, which carries the sheet of glass which is to be worked. The bed plate 32 is moved slowly from the left to the right in the machine as shown in the drawing. A sheet of glass 33 is laid upon the bed plate of the machine and is subjected to the operation of the tool, 2. A frame 5 extends over the glass transporting apparatus which has just been described. This frame 5 may be fixed in position or may be made movable as desired. During the operation of the machine it will be fixed when operated as shown in the drawings. The surfacing tool or facing, 35, may be constituted by a material depending upon the stage to which the work has progressed. The surfacing tool 35 according to the invention has an elongated rectangular active surface and extends over the whole width of the glass sheet in order to have the same action from one lateral edge of the sheet to the other. Because of the small amplitude of the periodic motion imparted to the tool, the dimension of the tool in the direction of the displacement of the glass sheet may be, for example, of the order of 20 to 50 times the amplitude of this periodic motion. Consequently, a given point of the glass sheet will be submitted to a great number of actions exerted in all directions during its passage under the same tool i. e. during the same phase of the treatment. Two coil springs, 3 and 4, bear upon the bottom of the frame 5 and upon the top of the beam 2; except for these springs, the beam is free to move. On opposite ends of the beam 2 are motors 6 and 7, which may be of any desired type, preferably electrical, and preferably synchronous motors. These motors have a shaft which extends out through the casing at each end as indicated at 36, 37 and on the ends of this projecting shaft are eccentric counter-weights or fly wheels 8 and 9. The fly wheels of the motor 7 and the fly wheels of the motor 6 are given the same orientation so that their vibratory effects will be combined and impart true homocircular motion of small amplitude to the beam 2. When the motors are energized, the eccentric weights revolve rapidly at the speeds of the motors and impart to the beam homocircular motion of small amplitude and high rate of revolution. The counterweights 8, 9 are preferably of the same weight, size and disposition. The motors are so constructed and coupled that the counterweights shall, at every instance, be oriented in the same direction and turn in synchronism and in phase. There were 20 claims and 13 references cited in this patent.

Tube and Cane Machines

Method of and Apparatus for Producing Thermometers. Patent No. 2,793,480. Filed November 29, 1955. Issued May 28, 1957. One sheet of drawings; none reproduced. Assigned to Owens-Illinois Glass Company by Frederick J. Shorten and Luther Zimmerman.

This invention is an improved method of and apparatus for producing graduated glass tube thermometers.

In accordance with the invention, a glass thermometer tube of conventional form and having a closed lower end as well as the usual graduation marks along its exterior surface, is charged with a measured quantity of mercury.

The tubes are taken at this stage and placed upright in a rack or holder and then the rack is positioned in a closable vacuum chamber. This chamber is partially inclosed in a receptacle and between the side walls and bottom of the chamber and receptacle is a mass of dry ice or like coolant. Between the tube holder and the bottom and adjacent side walls of the chamber is interposed a blanket of mercury. This mercury and the dry ice extract and conduct heat away from the thermometer tubes and result in lowering the mercury level in such tubes below the lowest reading point or graduation line. In the meantime, the chamber will have been tightly sealed by means of a cover plate or lid. With the mercury level thus lowered, the air and moisture are removed from the receptacle and the thermometer tubes by alternate flushing with nitrogen from a supply tank and air evacuation as effected by a vacuumizing unit. Both are connected by a pipe to the chamber. A valve regulates the flow of nitrogen and another valve controls the vacuumizing operation.

There were 7 claims and the following references cited in this patent: 2,324,556, Brown, July 20, 1943; 2,353,985, Barr, July 18, 1944; and 2,622,779, Smith et al., Dec. 23, 1952.

Miscellaneous Processes

Method and Apparatus for Masking Support Bodies. Patent No. 2,781,282. Filed September 21, 1953. Issued February 12, 1957. Four pages of drawings; none reproduced. Assigned to Libbey-Owens-Ford Glass Company by Willard L. Morgan.

This invention relates broadly to the thermal evaporation in a high vacuum of films or coatings upon support-bodies such as sheets of vitreous siliceous material and more particularly to an improved method and apparatus for masking certain portions of a support body to which a plurality of different films or coatings are to be successively applied.

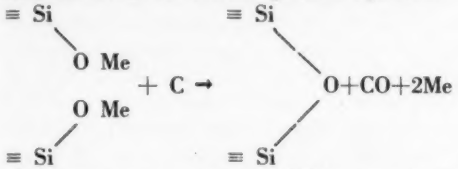
The electrically conductive article consists generally of a support body comprising a sheet of glass or other siliceous material, to one surface of which is applied a thin transparent electrically conductive film of metal which may, for example, be gold, silver, copper, iron or nickel. There is then applied along two opposite spaced edge portions of the metal film, electrode strips or bus bars for conducting electric current to the film. Finally, a hard transparent protective layer of dielectric inorganic material is applied to the electrically conduc-

(*Continued on page* 346)

Research Digest

Reduction Effects in Molten Glass

• J. E. PENA IN THE December 1957 issue of the *Journal of the Society of Glass Technology* describes and discusses various experimental observations which have led to the formulation of the following basic equation:



where Me represents a network-modifying metal and C a reducing agent. The author considers that this type of reaction expresses effects which can be produced by reduction processes in the manufacture and working of glass.

The three possible reaction products and their manifestations in glass are:

1. Compacted crystalline structures produced by removal, by the reducing agent, of oxygen from among a number of non-bridging oxygens, with regeneration of bridging bonds of the type Si-O-Si (Zachariasen, 1932). This process may also be effected by a reducing atmosphere above the molten glass and manifests itself by the appearance of crystalline silica.

2. Oxidation products of the reducing agent (such as carbon and hydrogen) which are gaseous at the working temperatures and which may become entrapped in the glass and appear as blisters and bubbles.

3. Modifier cations which separate as metallic atoms and diffuse into the melt. Because of their extremely small size, such metallic particles can produce marked coloring effects.

In spite of the fact that the combination coal-sulphate has been in continual use for a long time as a refining medium, unexpected phenomena occasionally occur. Many manufacturers have encountered the surprising appearance of a separate solid phase in the form of large or small 'icebergs' floating on the melt. This has been identified as consisting of aggregates of cristobalite, commonly referred to in the French glass industry as 'mousse silicieuse'.

It has been demonstrated that the separation of cristobalite in this manner is associated with excess coal in the batch.

The occurrence of scum is directly related to the amount of coal in the batch; scum is formed when the coal is above a certain proportion. In the actual large-scale trial, the weight ratio coal/Na_2SO_4 was increased stepwise from the original value of 4.54 per cent at intervals of several days. When the ratio reached 8.78 per cent cristobalite aggregates appeared on the melt. With successive decreases in the amount of coal, freedom from cristobalite occurred at a ratio of 6.8 per cent. A study of the possible mechanism of the processes involved led to the formulation of that expressed in the equation.

In some phase of the melting and subsequent thermal treatment of glass, heating may be effected by the combustion of a gas containing a high proportion of hydrogen, perhaps even higher than 50 per cent. Continuous contact between such flames and the glass surface can initiate the formation of cristobalite by a reduction process similar in chemical nature to that described above.

The fact that the crystal formation is frequently accompanied by an amber coloration, discussed below, appears to be further evidence in support of the proposed mechanism.

This type of crystallization may be observed at the walls of the cooling chamber in the Libbey-Owens process and is produced by the action of the lateral burners.

It is also considered that the formation of cristobalite, usually accompanied by an amber coloration, can always be expected in any region where there is prolonged contact between the melt and hydrogen or other reducing gas. The work of Leger (1956) on the solubility and diffusion of gases in glass supports this view.

Some of the effects produced by reaction between molten glass and introduced iron articles are probably well known to all glass makers. A spectacular result which is always observed is the formation of large bubbles which burst at the glass surface with combustion of the liberated gases.

Another result is the formation of greenish-brown or yellowish-brown threads diffusing from the contact surface into the melt.

In spite of their rather startling beginning, both these effects gradually die out, although the contact conditions remain apparently unchanged, and the piece of iron still exists in the glass at the high temperature. After removal of the iron it has a shining polished surface and the surrounding glass is free from bubbles and coloration.

It is considered that these characteristics of iron-glass contact merit special consideration with regard to the possibility of their association with the oxidation-reduction processes studied here.

The study of the simultaneous production of bubbles and crystals and also the correlation between size and frequency of the bubbles and the quantity of contained crystals has led to the association of the liberation of carbon monoxide and carbon dioxide with a redox process involving the glass structure.

When attempting to formulate this process as a classical reaction, the initial difficulty encountered, in order to balance the chemical equation, is the acceptance of the separation of network-modifying elements as free metals. The possibility of this phenomena does not appear in the literature and it was only after much consideration that the mathematical necessity of the separation of neutral metallic atoms involved in satisfying equation (1) was regarded as a possible interpretation of the colors produced as being attributable to such atoms actually being formed in the molten glass.

It is now considered that a reaction of the type ex-

pressed in the form of equation (1) can quite coherently explain the composition of the gases produced in bubbles as a result of interaction between iron articles and glass.

The relative proportions of carbon monoxide and dioxide and their possible co-existence with oxygen will be governed by the thermodynamical characteristics as related to temperature, the relative concentration of carbon and the type and nature of the modifying cation in question (ionic size and charge). It should also be noted that in a commercial tank furnace the glass is not of the same composition at all points of its mass, nor is there a uniform distribution of modifier cations. For this reason, in the above reactions, Me can be any of the modifier cations present in the melt (Na^+, K^+, Ca^{2+}, Mg^{2+}, Pb^{2+}, etc.) and variations in conditions at the iron-glass contact point can have a powerful influence on the course of the reactions.

When considering the distribution of cations, attention must also be paid to the behavior of chemically combined water in the glass, which is generally agreed as participating in the glass structure. The existence of bonds of the type Si-O-H must therefore be accepted, which can take part in the reactions according to the equation:

$$\begin{array}{l} \equiv \text{Si-O-H} \\ \\ \equiv \text{Si-O-H} \end{array} \quad + \text{C} \rightarrow \quad \begin{array}{l} \equiv \text{Si} \\ \quad\quad \text{O} + \text{CO} + \text{H}_2 \\ \equiv \text{Si} \end{array}$$

Thus, a considerable number of the elementary reactions occurring separately or together can yield, by reduction, macroscopic bubbles with a diversity of composition of included gas, so that the iron-glass reaction is expected to yield mixtures with varying proportions of carbon monoxide, carbon dioxide, and hydrogen (and sometimes, also, oxygen).

It is suggested that, when considering the interaction between iron and glass, it is the carbon in the iron which takes part in the actual reaction process. It is assumed that pure iron does not enter into such reactions which are effected only by carbon, and probably also sulphur and phosphorus.

A final deduction to be made from the general reaction equation is the possibility of the formation and separation in the glass of free atoms of the network-modifying elements. A number of examples is now given of hitherto not understood phenomena which can be explained on this basis.

It has been assumed, in the past, that the colored threads produced by reaction at an iron-glass contact should be attributed to dissolution of iron in the glass. According to the interpretation considered above, however, it is probable that iron atoms cannot dissolve. The conclusion arrived at, therefore, is that the coloration is due to the presence of modifier elements in the elementary state. Considered in more detail, the mechanism of color formation may be attributed to the diffusion into the glass of a fog of metallic sodium in a finely divided state. There is strong evidence in support of this view in the behavior of molten salts under electrolysis.

It is possible that, for an initial contact period between iron and glass, the coloration may be produced by dissolution of a surface layer of iron oxide. A change in the color produced from a greenish shade to amber indicates the solution of all the iron oxide and the beginning of the process involving the separation of free metal.

Further theoretical and experimental evidence also suggests that sodium is the modifying cation which has the greatest probability of separating in the free atomic state.

This explanation provides a simultaneous solution to two problems, the mathematical necessity of accepting the formation of free metals in the postulated redox process and the formation of an amber color which cannot be attributed to iron atoms because of their insolubility.

A remarkable feature of the use of coal in a glass batch is the fact that its introduction is for the purpose of reducing the sodium sulphate also present, and the general acceptance of the assumption that its behavior is quite specific. Other possible reactions involving carbon must, however, be considered.

A well-known and long-used process in the metallurgy of sodium is the interaction between carbon and sodium carbonate, in the presence of calcium carbonate, to produce metallic sodium. According to the above arguments the occurrence of this reaction in a glass batch could yield a fog of free sodium leading to an amber coloration.

In a previous paper the author has discussed a possible chemical mechanism involved in the formation of deposits of sodium sulphate on cool surfaces in the working end of a furnace. It is considered that explanations for this phenomena which have previously been given are not satisfactory with regard to the situation and temperature conditions involved.

The process put forward may be summarised by the following series of reactions.

$$\begin{array}{ll} Na_2 + O_2 & \rightarrow \quad Na_2O_2 \\ SO_2 + (+Na_2O_2) & \rightarrow \quad SO_3 \\ SO_3 + Na_2O & \rightarrow \quad Na_2SO_4 \end{array}$$

Further work is in progress to provide additional experimental justification of the presence of elemental sodium in glass and its coloring effects.

DU PONT OPENS NEW LAB

Opening of a new $5 million laboratory to provide service to customers and for evaluation of new or improved products of the DuPont Company's Electrochemicals and Pigments departments was announced by the company.

Although some facilities are shared jointly by the two departments, the building houses separate laboratories for product development in different chemical fields.

For both departments, the laboratory provides a center for research work on problems of customers, for customer visits, development work on new products and new uses for established products and training of field technical representatives. Sales service facilities for the Electrochemicals Department formerly were maintained at its Niagara Falls plant. Prior to the completion of the new building, the Pigments Department operated separate service laboratories at Newark, N. J., and at its Newport, Del., plant.

The laboratory contains 81,000 square feet of floor space, including 150 separate rooms and laboratories.

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during March, 1958 was as follows: *Flat Glass*: A preliminary figure of 21,900 given for March, 1958 indicates a decrease of 14.1 per cent from the adjusted 25,600 reported for February, 1958. *Glass and Glassware, Pressed and Blown*: An increase of .5 per cent is shown by the preliminary figure of 75,600 reported for March, 1958, when compared with the adjusted figure of 75,200 recorded for February, 1958. *Glass Products Made of Purchased Glass*: The preliminary figure of 11,200 given for March, 1958 indicates a decrease of 7.4 per cent from the previous month's adjusted figure of 12,100.

Payrolls in the glass industry during March, 1958 were as follows: *Flat Glass:* A decrease of 16.7 per cent is shown in the preliminary $10,124,102.16 given for March, 1958 when compared with February's adjusted $12,160,685.82. *Glass and Glassware, Pressed and Blown:* An increase of 2 per cent is shown in the preliminary $28,171,432.80 reported for March, 1958, when compared with the previous month's adjusted $27,622,692.43. *Glass Products Made of Purchased Glass:* A preliminary figure of $3,318,454.05 was reported for March, 1958. This is a decrease of 5.9 per cent when compared with the adjusted figure of $3,527,491.89 recorded for February, 1958.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

Narrow Neck Containers

	Apr., 1958
Food	1,082,000
Medicinal and Health Supplies	1,256,000
Chemical, Household and Industrial	799,000
Toiletries and Cosmetics	812,000
Beverage, Returnable	586,000
Beverage, Non-Returnable	110,000
Beer, Returnable	407,000
Beer, Non-Returnable	672,000
Liquor	674,000
Wine	371,000
Sub-total (Narrow)	6,769,000

Wide Mouth Containers

Food	3,164,000
Medicinal and Health Supplies	378,000
Chemical, Household and Industrial	148,000
Toiletries and Cosmetics	281,000
Packers' Tumblers	46,000
Dairy Products	128,000
Sub-total (Wide)	4,145,000
Total Domestic	10,914,000
Export Shipments	221,000
TOTAL SHIPMENTS	11,135,000

*This figure includes Fruit Jars and Jelly Glasses.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production Apr., 1958	Stocks Apr., 1958
Food, Medicinal and Health Supplies; Chemical, Household and Industrial; Toiletries and Cosmetics	Narrow Neck	3,878,000	6,873,000
	Wide Mouth	*4,054,000	*6,178,000
Beverage, Returnable		781,000	1,982,000
Beverage, Non-Returnable		104,000	215,000
Beer, Returnable		481,000	515,000
Beer, Non-Returnable		612,000	852,000
Liquor		726,000	1,342,000
Wine		334,000	639,000
Packers' Tumblers		45,000	105,000
Dairy Products		143,000	326,000
TOTAL		*11,158,000	*19,027,000

*This figure includes Fruit Jars and Jelly Glasses.

Glass container production: Production based on figures released by the Bureau of the Census, Industry Division, was 11,158,000 gross during April, 1958. This is a decrease of 8.6 per cent from the previous month's production figure, 12,216,000 gross. During April, 1957, glass container production was 11,786,000 gross or 5.3 per cent above the April, 1958 figure. At the end of the first four months of 1958, glass container manufacturers have produced a perliminary total of 45,987,000 gross. This is 3.2 per cent below the 47,524,000 gross produced during the same period in 1957.

Shipments of glass containers during April, 1958 came to 11,135,000 gross, a decrease of 1.1 per cent from March, 1958 shipments which totaled 11,258,000 gross. Shipments during April, 1957 amounted to 11,321,000 gross or 1.6 per cent above April, 1958. At the end of the first four months of 1958, shipments have reached a preliminary total of 44,043,000 gross, which is 2.4 per cent over the 43,011,000 gross shipped during the same period of the previous year.

Stocks on hand at the end of April, 1958 came to 19,027,000 gross. This is 0.5 per cent below the 19,132,000 gross on hand at the end of March, 1958, and 5.3 per cent higher than the 18,018,000 gross on hand at the end of April, 1957.

OWENS-CORNING FIBERGLAS PURCHASES KAYLO DIV., O-I GLASS

Owens-Corning Fiberglas Corporation has purchased the Kaylo Division of Owens-Illinois Glass Company.

The acquisition includes the manufacturing plant at Berlin, N. J. where Kaylo, an industrial heat insulation product effective up to 1,800 degrees F. is produced.

Kaylo block and pipe products have been distributed nationally since April, 1953, by Owens-Corning to supplement its own line of Fiberglas industrial insulations. Kaylo insulations were introduced by Owens-Illinois in 1943 and since then have attained wide acceptance in a variety of applications.

Kaylo insulation products are used largely in the power, chemical, refining and other process industries for such equipment as chilling pits, condensers, dryers, evaporators, furnaces, heat exchangers, hot air ducts, kilns, and glass annealing furnaces.

New Equipment and Supplies

NEW ABRASIVE PAPER

Armour and Company, Coated Abrasives Division, Alliance, Ohio, has prepared for glass and mirror manufacturers a new coated finishing product to clean, swipe edges, etc. The paper is said to last longer, cut faster and give a better surface finish than waterproof paper and to be both easier and more economical to use. Since the product is a dry sheet rather than a wet sheet, it is no longer necessary to use either water or waterproof clothing during the finishing sanding operation.

The paper has a special coating which prevents loading and clogging of the abrasive side of the paper. Residue can be easily removed from the paper by gently slapping the paper with the hand. The finishing paper can be used indefinitely while ordinary product must be discarded as soon as it loads up. The coating will not rub off during sanding nor will it come off when moisture is present.

TEMPERATURE CONTROLLER

Illinois Testing Laboratories, Inc., 420 North LaSalle Street, Chicago 10, Ill., has introduced a new temperature controller referred to as a pyrotroller. This pyrometer controller can be applied wherever a thermocouple can be used to measure temperature. The instrument is said to be highly dependable, after considerable field experience, simply because there is a minimum of components involved in this design.

The compact size will require only the smallest area of panel space. The small case provides a further advantage should installation in hazardous locations be necessary. The pyrotroller can be placed in the smallest conduit housing.

NEW MOTOR BASES

Automatic Motor Base Company, Windsor, N. J. announces two new models of motor bases for maintaining the proper amount of tension in belts. Sizes range from 1/4 to 500 H.P.

Tension is effected by a spring which also compensates for a considerable amount of belt stretch before any readjustment is necessary. When required readjustment is made while operating under load merely by turning a screw. No bolts or nuts are disturbed and initial pulley alignment is always maintained.

The compact, pancake construction of these bases is said to make them particularly adaptable to those applications where space is at a premium. They can be mounted in any position, and the direction of pulley rotation is immaterial.

It is claimed that these bases reduce maintenance and down-time, increase the life of belts and bearings, and sustain maximum machine output.

LARGE CAPACITY VIBRATORY FEEDER

Eriez Manufacturing Company, Erie 6, Pa., has begun production of a new heavy duty electro-permanent magnetic vibratory feeder, rated at four tons an hour. The new unit, model V3B-40A, is claimed to have the design advantages of the company's existing line of feeders. These characteristics include an electro-permanent magnetic drive which requires no rectifier, but is merely plugged in to the normal AC line. This is said to simplify installation, insure lower power consumption and minimal maintenance. The drive system which is coupled with new disc style glass fiber springs affords a precisely controlled delivery of material.

The new unit can deliver a wide range of material densities—from 40 to 150 lbs. per cubic foot. The base is designed to allow the feeders to be mounted side by side, back to back or in tandem.

CATALOGS RECEIVED

Eisler Transformer Company, Inc. of 16 North Salem Street, Dover, N. J., a division of Eisler Engineering Company, Inc., has just issued a four page brochure showing part of their new facilities, and different types of transformers constructed by the company.

Write for Catalog #TR-58 direct to the company.

Cratex Manufacturing Company, 1600 Rollins Road, Burlingame, Cal., has prepared an industrial catalog describing the company's rubberized abrasives for deburring, smoothing and polishing applications. The 8-page catalog contains advanced application information, operating instructions, tables, illustrations and the latest technical information. Write direct to the company.

Cobalt Information Center, c/o Battelle Memorial Institute, 505 King Avenue, Columbus 1, Ohio, has prepared a special report, "Machining of Cobalt Superalloys".

Machining data and operating instructions are given for 22 superalloys and 3 metal-glass sealing alloys. Drilling, turning, facing, milling, broaching, reaming, shaping, tapping, cutoff, and unusual machining methods of superalloys are discussed. Tables provide information on tool material and geometry, tool material guides, machinability index and horespower required at the cutting point, and on the conversion of SFM to RPM. Twenty-three references are included.

Eriez Manufacturing Company, 70D Magnet Drive, Erie, Pa., offers a 48 page booklet, "Magnetic Ideas from Eriez" which describes the applications of permanent, non-electric magnetism in modern materials handling and magnetic separation equipment. The booklet has three sections: separators, used to guard against tramp iron damage and to isolate magnetic and non-magnetic materials; magnetic automation units for conveying, controlling or elevating metal parts and materials; and vibratory units.

Applications of magnetism in the glass and ceramic industries are included. The booklet may be had without charge from the company.

Philips Electronics, Inc., Instruments Division, 750 South Fulton Avenue, Mount Vernon, N. Y., has available gratis a 6-page folder describing the company's EM-75B electron microscope. The text explains the electron optical system, filament replacement, lens system and viewing screen, vacuum system, power supply, and instrument operation.

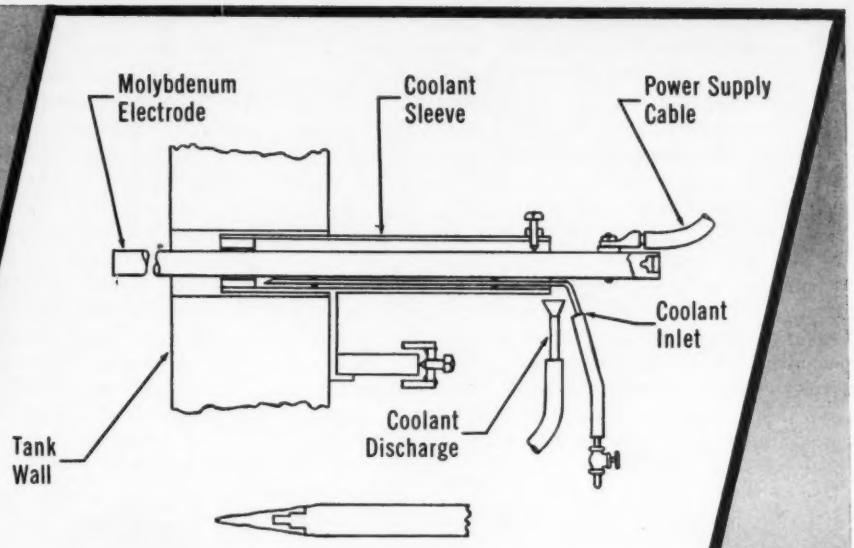
Illustrated with photos, drawings and micrographs, the new folder deals in detail with condenser, objective and projector lenses. Other sections cover specimen holder and airlock, 35 mm. roll film Cassette, plate holder, beam wobbler, electromagnetic alignment and mechanical stability.

H. K. Porter Company, Inc., Refractories Division, has published a new 20 page brochure, "Glass Industry Refractories".

Refractories used in glass melting tank constructions, pot furnaces, and day tanks are described from manufacture to end use. Every refractory needed to build a complete glass melting tank is included: tank sidewall and bottom blocks, upperstructure refractories, mandrels, boots, feeder parts, covered and open glass melting pots, pot accessories, stoppers, clays, mixes refractory brick and mortars.

Copies of this brochure are available upon request from the Manager—Glass Products, Laclede-Christy Works, Refractories Division, H. K. Porter Company, Inc., 2064 Hampton Avenue, St. Louis 10, Mo.

Hot molybdenum ingots are forged into round billets, then further processed to make 1¼-inch diameter electrodes for glass melting furnaces using the Penberthy electrode assembly shown in the diagram.



Electrodes are joined by threaded ends to provide maximum use

Fansteel Molybdenum Electrodes

for electric melting...

here's what they cost:

Based on actual operational costs covering a production of 16,027 tons of flint glass over a period of several months, electrode cost amounted to *only 2½ cents per ton!*

here's what you get:

1. Increased production (10 to 30%)
2. Longer furnace wall life
3. Improved glass quality

FANSTEEL ELECTRODES CAN BE INSTALLED WITHOUT FURNACE SHUT-DOWN . . . are 99.9% pure, give off a colorless oxide, have high thermal and electrical conductivity, and high temperature strength. Write for more complete information.

K577

FANSTEEL METALLURGICAL CORPORATION

NORTH CHICAGO, ILLINOIS, U. S. A.

PITTSBURGH PLATE APPOINTS W. C. OBERLIN CHIEF ENGINEER

Appointment of William C. Oberlin as chief engineer for the glass division of Pittsburgh Plate Glass Company has been announced by John M. Fisher, director of engineering, glass division. Mr. Oberlin succeeds Ralph D. Bole who has retired, effective May 1, to climax a career of 36 years with Pittsburgh Plate.

Mr. Bole joined the Pittsburgh general office as a draftsman in the engineering department in 1922 and a year later transferred to Creighton, Pennsylvania, as general office engineering representative. He was named assistant engineer in 1928 and had served for nearly 20 years as chief engineer at the time of his retirement. A native of Emsworth, Pennsylvania, Mr. Bole was graduated from Pennsylvania State University with a degree in mechanical engineering.

Mr. Oberlin had served as associate chief engineer following his transfer to Pittsburgh in January from the company's Crystal City, Missouri, plate glass plant. He joined Pittsburgh Plate in 1948 as an engineer at Crystal City and later served as assistant plant engineer and assistant to the manager before moving to Pittsburgh. He is a mechanical engineering graduate from the University of Kansas.

KNOX GLASS EXPANDS TEXAS PLANT

Knox Glass Incorporated, on Saturday, May 10th, formally dedicated its new $750,000 amber glass manufacturing facilities at the company's Palestine, Texas, plant. The new furnace, fabricating machines and lehrs will increase production at the plant by 40 per cent.

Principal speaker at the dedication ceremony was the Honorable Olin Culberson, Chairman of the Texas Railroad Commission, who congratulated the company for its courage and foresight in proceeding with expansion plans in a recession period. Dr. Arthur W. Wishart, KGI president, responded on behalf of the company.

This aerial photo shows the area occupied by the expanding Palestine, Texas, plant of Knox Glass Incorporated. The $750,000 building program just completed brings total plant and warehouse space up to 185,000 square feet on the 46-acre site just outside the city limits.

In addition to the installation of amber facilities, a new warehouse, new office building. larger mould maintenance shop and many other improvements were included in the expansion program just completed. At an open house held in conjunction with the formal ceremonies, several hundred visitors were conducted on a tour of the plant.

The new amber tank adds 60 tons of glass to the previous 150 tons daily capacity of the plant and the two fabricating machines will form containers to the customers' specifications. KGI's amber tank is the second such facility in all of Texas.

The Palestine plant—one of seven now operated by the company, which has an 8th plant under construction at Danielson, Connecticut—is located on a 46 acre site just outside the city limits of the East Texas town. Conveniently located about midway between Dallas and Houston, Palestine has excellent rail and highway transportation, and the plant itself is served by a spur of the Missouri Pacific Railroad Company.

Established in 1941, KGI's Palestine plant originally employed about 300 people. An applied color label decorating department, vastly expanded warehousing, a fleet of 11 company owned tractor and trailor units and many other improvements have been added in the past few years, bringing the total number of employees to nearly 500.

C. Drane

Manager of the Palestine plant is Clarence Drane, a veteran of 25 years service with the company. Transferred from the Jackson, Mississippi, plant when the installation at Palestine commenced operations in 1941, he was named plant manager in January, 1953. Prior to his appointment he had served for several years as service manager.

Besides President Wishart and Mr. Drane, other company officials present for the ceremonies were Walter M. Furlow, vice president—marketing; James A. Giddings, sales manager—south; Howard B. Steele, manufacturing manager; Harold A. Youkers, director of engineering; and L. H. Keller, manufacturing manager—south.

CORNING EXHIBITS VENETIAN GLASS

The largest and most comprehensive exhibition of Venetian glass ever held in this country will open in mid June at The Corning Museum of Glass in the Corning Glass Center, Corning, New York. Entitled "Three Great Centuries of Venetian Glass", it will comprise 126 glass objects selected from nine collections both here and abroad.

Representing the major decorative techniques, with the finest examples available, the exhibition is said to form a unique representation of one of the greatest periods in glassmaking history: Venice in the 15th, 16th, and 17th centuries. Its purpose, according to Paul N. Perrot, Assistant Director of the Museum who organized the exhibition, is to stress to the American public the greatness of Venice's contribution to the art of glassmaking and to emphasize the brilliant achievements of this period.

In order to relate the glass to the period in which it was produced, other art objects including paintings, bronzes, ivories, ceramics, furniture, miniatures, and fabrics will be displayed.

Porcelain insulators have quality literally thrust upon them. It's the prime requirement and presupposes the finest in raw material, like Wedron Silica, the finest silica available today—pure, white, uniform!

The obvious merits of quality can be yours with Wedron Silica

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for ceramics

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99.9% PURE SILICA WEDRON SILICA COMPANY INDUSTRIAL SAND

Send for illustrated brochure on Wedron sands.

Inventions . . .

(*Continued from page* 338)

tive coating between the spaced electrodes. The electrically conductive film, electrodes, and protective layer are adapted to be separately and successively applied to the support body, and it is preferred that they be deposited upon said support body by direct thermal evaporation, within a vacuum, of small amounts of the materials making up said films or coatings.

There were 14 claims and the following references cited in this patent: 2,151,457, Williams, Mar. 21, 1939; 2,189,580, Hewlett, Feb. 6, 1940; 2,273,941, Dorn, Feb. 24, 1942; 2,453,582, Morgan, Nov. 9, 1948; 2,463,906, Pride, Mar. 8, 1949; 2,614,524, Haynes, Oct. 21, 1952; 2,629,757, McKay, Feb. 24, 1953; 2,633,427, Dimmick et al., Mar. 31, 1953; and 2,675,740, Barkley, Apr. 30, 1954.

Corner Grinding Mechanism. Patent No. 2,782,569. Filed Dec. 11, 1952. Issued Feb. 26, 1957. Two sheets of drawings; none reproduced. Assigned to Pittsburgh Plate Glass Company by Bruce D. Robbins.

This invention relates to machines for edge grinding glass plates or the like, and more particularly to a corner portion grinding attachment for use on such machines.

The corner portion nipper or grinding wheel is preferably a small diamond type wheel about five inches in diameter, and is used only for grinding the corner portions of glass work pieces. The use of such a corner portion grinding attachment eliminates the necessity for expensive corner portion segments for the segmental templates, and also reduces wear on the main edge grinding wheels.

The corner portion nipper attachment is easily installed on rotary edge grinding machines already in use.

There were three claims and the following references cited in this patent: 1,958,526, Weber, May 15, 1934; 2,010,922, Leonard, Aug. 13, 1935; 2,038,150, Weber, Apr. 21, 1936; 2,080,280, Klages, May 11, 1937; 2,527,791, Brink, Oct. 31, 1950; 2,579,337, Reaser et al., Dec. 18, 1951; and 2,597,180, Reaser et al., May 20, 1952.

Apparatus for Dispensing Plaster. Patent No. 2,782,756. Filed December 13, 1954. Issued Feb. 26, 1957. Three sheets of drawings; none reproduced. Assigned to Pittsburgh Plate Glass Company by Charles S. Cusick and Robert V. Lange.

It has been discovered that troubles during grinding and polishing may be minimized by providing a border of plaster along each lateral edge of the glass sheets. The thickness of these borders at the glass-plaster interface preferably should equal the thickness of the glass. This plaster border must have a horizontal upper surface at its interface with the glass that is in the same plane as the rough rolled glass sheet. Therefore, support is provided for the edges of the glass sheets in the regions where glass failure is likely to occur. Also, by eliminating abrupt edges from the glass, the useful life of the polishing felts has been extended considerably.

Apparatus has been developed capable of applying the edge border. This apparatus includes an endless belt mounted on free-running pulleys and caused to rotate by frictional engagement of the pulleys against an edge of the continuous tables; a dispenser for applying accelerator fluid into the channel formed between the belt and the edge of the glass; a plaster hopper for applying plaster of Paris into the same channel; a tamping wheel to adjust the thickness of the plaster border to that of the glass; and scraping means for removing any excess plaster so that the thickness of the plaster border conforms to that of the rough rolled sheets of glass, especially at the interface along the edge of the glass.

There were five claims and the following references cited in this patent: 1,194,520, Lewis, Aug. 15, 1916; 1,631,203, Hitchcock, June 7, 1927; 1,895,934, Leyland, Jan. 31, 1933; 1,934,794, Fisher, Nov. 14, 1933; 2,212,351, Moran, Aug. 20, 1940; and 2,363,631, Walters, Nov. 28, 1944.

Electric Resistance Heater. Patent No. 2,784,287. Filed Dec. 22, 1954. Issued March 5, 1957. One sheet of drawings; none reproduced. Assigned to Blue Ridge Glass Corporation by Theodore W. Glynn.

This invention relates to electric resistance heaters, and more particularly to those in which an electric heating element covers one side of a glass plate.

A heating element is disposed in a predetermined pattern on one side of a glass plate, on which there also is a pair of electric terminals for the element. The heating element is formed from a pair of electric conductors of substantially the same length connected in parallel between the terminals. The pattern has a border in the form of a decorative scroll which is divided into two parts of substantially the same length. Each of these parts forms a portion of a different one of the conductors. Preferably, the pattern is rectangular and the scroll border is a Grecian scroll. The conductors are arranged in such a way as to provide a blank display area at the center of the heater, where a trademark or other identifying matter may be placed.

There were 5 claims and the following references cited in this patent: 1,771,273, Smith, July 22, 1930; 2,222,742, Ducret et al., Nov. 26, 1940; 2,495,788, Trist, Jan. 31, 1950; 2,504,146, Mossin, Apr. 18, 1950; 2,512,875, Reynolds, June 27, 1950; 2,622,178, Glynn, Dec. 16, 1952; 2,623,971, Glynn, Dec. 30, 1952; 2,641,675, Hannahs, June 9, 1953; and 2,699,303, Chilman, Jan. 11, 1955.

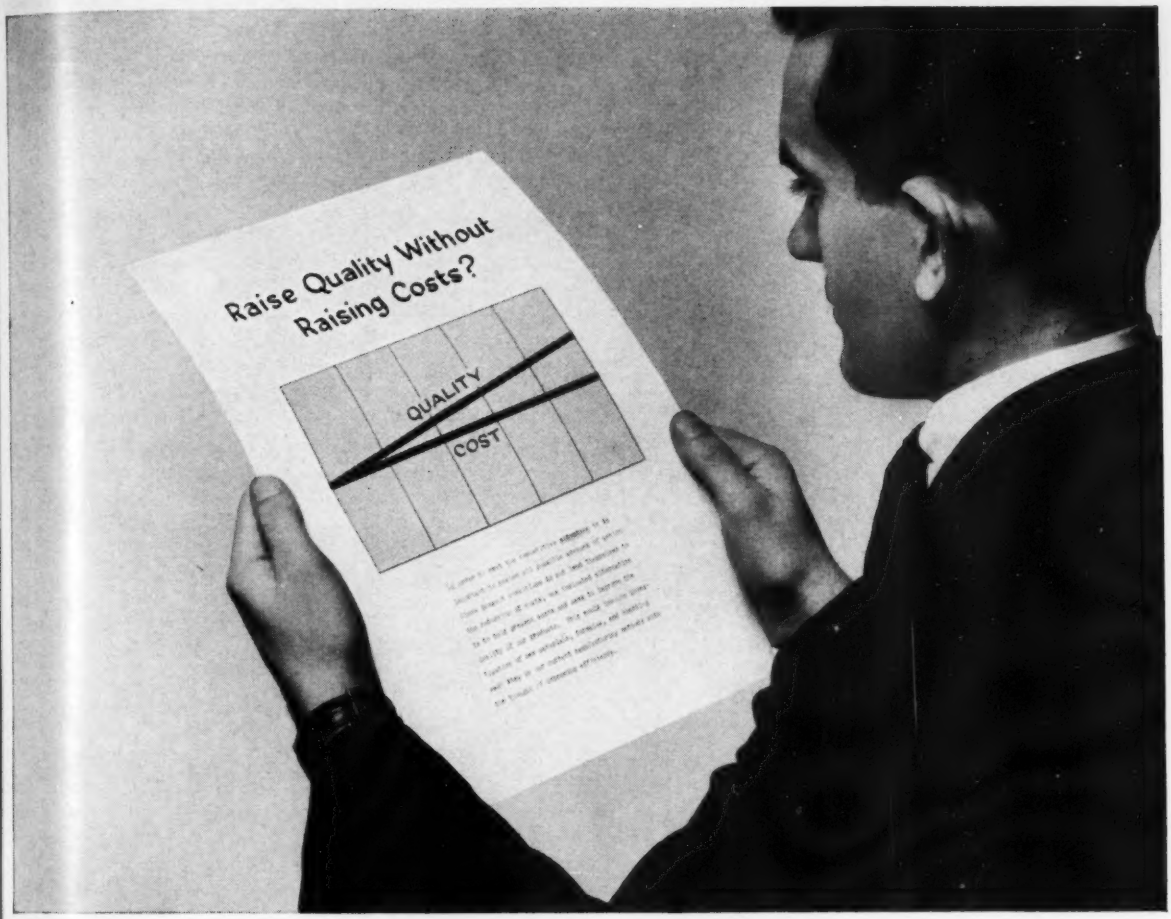
L.O.F., PITTSBURGH PLATE SIGN NEW LABOR CONTRACT WITH GLASS CUTTERS

Libbey-Owens-Ford Glass Company and Pittsburgh Plate Glass Company announced that they had signed a new labor contract with the Window Glass Cutters League of America, AFL-CIO, to expire on April 25, 1959.

The new contract provides an increase of two cents per 100-foot box, improved pension benefits and other contractural changes.

This agreement covers approximately 1,000 cutters employed at the plants of the two companies located at Shreveport, La.; Charleston and Clarksburg, W. Va.; Mt. Vernon, Ohio, and Henryetta, Okla.

The Libbey-Owens-Ford Glass delegation was headed by L. G. Bryan and M. B. Burwell and the Pittsburgh Plate Glass delegation by D. J. Sherbondy and H. L. Halbach. The Cutters League's delegation was headed by Glen McCabe, national president.



HOW ARE YOU MEETING TODAY'S COMPETITION?

Many progressive glass manufacturers are exploring methods for producing better products without increasing costs as one means of meeting today's competition.

SOLVAY customers faced with this problem can call on the Glass Section of our Technical Service to assist them. With a vast store of technical and practical knowledge and experience and most modern laboratory facilities, SOLVAY's glass specialists are in a position to offer assistance on methods, batch formulations and materials.

Technical aid is just one of SOLVAY's extra services for glassmakers. Others include prompt carload delivery service from three shipping points, over 200 l.c.l. stock points, and field service representatives working from 13 widely-situated branch offices.

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Cleaning Compounds • Methyl Chloride • Ortho-dichlorobenzene • Monochlorobenzene • Chloroform • Sodium Nitrite • Chlorine • Caustic Soda
Vinyl Chloride • Mutual Chromium Chemicals • Para-dichlorobenzene • Ammonium Chloride • Aluminum Chloride • Carbon Tetrachloride
Methylene Chloride • Hydrogen Peroxide

Glass Division Papers . . .

(*Continued from page* 324)

2. In the system Li_2O-CaO-Al_2O_3-SiO_2, stable glasses are formed at levels of 5.0, 10.0, 15.0, 20.0 and 30.0 weight per cent calcia. Glasses at the 5.0 per cent level have lithia contents covering the same approximate range as those in the Li_2O-Al_2O_3-SiO_2 system. At the other calcia levels, stable glasses were formed at lithia contents lower than those in the ternary system. At all levels, except 30.0 per cent, the areas of glass formation penetrated farther into the alumina portion of the triaxial than did the area in the ternary system.

3. In the ternary and quaternary systems studied, surface and volume resistivity and chemical durability decreased as lithia content increased. The same study showed that thermal expansion, dielectric constant, power factor, index of refraction, and density increased with increasing lithia content.

4. Molar replacement of lithia by soda in four of the glasses studied indicated that soda raised both expansion and dielectric constant by approximately 10 per cent, increased the density about 2 per cent, slightly lowered the index of refraction, and increased the alkali loss from 3 to 6 times. In addition, the soda glasses required temperatures about 200° F. higher than the original lithia glasses before attaining the same pourability.

O. L. Anderson, Bell Telephone Laboratories, Inc., Murray Hill, N. J., was chairman of the afternoon session.

Some New Inorganic Glasses Fluid Below 400° C. by S. S. Flaschen and A. D. Pearson, Bell Telephone Laboratories, Inc., was the first paper. The paper was given by Dr. Flaschen, who presented some highly interesting results concerning unusual inorganic glasses of high fluidity.

The purpose of such glasses is to pot electronic devices and protect such equipment during use. The desirable requirements are good stability, chemical inertness, and low viscosity or high fluidity, as well as good melting characteristics and dielectric properties.

The starting point for such glasses was As_2O_3; however, the better glasses were developed in a series involving As-S-Tl and As-Se-Tl. The glasses were melted in Pyrex crucibles in an atmosphere of nitrogen and later examined for crystallinity by means of the X-ray. Because high fluidity was desired, the characteristics at a viscosity of 10 poises was of great importance.

Some of the better glasses, in the arsenic-sulfur-thallium series, were as follows:

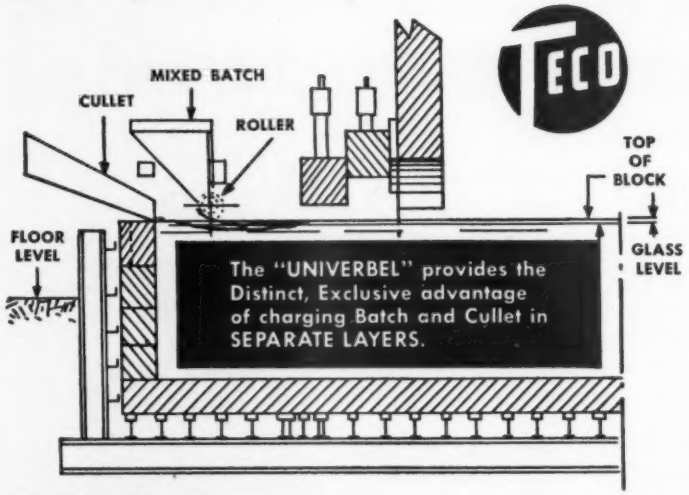
As	25-30 per cent
S	34-40 per cent
Tl	35-36 per cent

Thallium was shown to have a profound influence on both As-S and As-Se mixtures by lowering the melting temperature and viscosity of the melts. Good glasses were apparent up to approximately 35 per cent Tl.

Partial substitutions that were investigated included Sn, Pb, Sb, Bi, and Ge. These unusual glasses also

(*Continued on page* 350)

Better Glass with 'UNIVERBEL' Batch Charger



The unique "Univerbel" Batch Charger for feeding batch and cullet to glass melting furnaces was developed and perfected in Belgium and is being used with exceptional success in many European countries as well as Great Britain, Canada and the United States.

It is ideally suited for charging melting furnaces in plants producing WINDOW GLASS, PLATE GLASS, CONTAINERS, GLASS BLOCK, GLASS WOOL, GLASS FIBER and many other materials and products.

◀ Illustration at the left shows the "Univerbel" charger in a sectional drawing of the doghouse into which the batch and cullet are fed by the charger. Rotation of the Feeding roll moves the batch and cullet into the furnace.

Write or Phone FOR FURTHER INFORMATION

TOLEDO ENGINEERING *Company*

DESIGNERS & BUILDERS OF GLASS MELTING FURNACES

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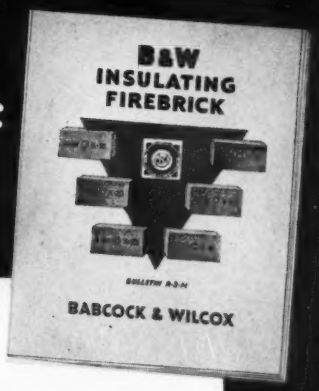
Why B&W IFB for Glass Furnace Insulation ?

- Lightest weight
- Lower conductivity
- Lower heat storage
- High hot load strength
- Simplified construction
- Lower temperature around tank



Since B&W IFB are lighter than other insulating firebrick, they insulate better. Thus, they save more fuel.

The higher insulating value and lower conductivity of B&W Insulating Firebrick reduce radiation, which is lost heat. This not only results in lower fuel costs, but also provides better working conditions around the tank for glass furnace operators.

In addition, B&W IFB offer excellent refractory qualities. They have ample hot load strength to prevent deformation. Shrinkage is negligible. B&W IFB are easy to handle, install and cut to form special shapes, using only wood working tools.

Lightweight B&W IFB save in other ways, too. They can be bonded with firebrick walls to reduce air leakage and air infiltration, further reducing fuel consumption.

****Write for Bulletin R-2-H giving more data on B&W Insulating Firebrick.***

B&W REFRACTORIES PRODUCTS:
B&W Alimul Firebrick • B&W 60 Firebrick • B&W Junior Firebrick
B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide • B&W Ramming Mixes • B&W Kaowool

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REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

Milestones in Glass Progress

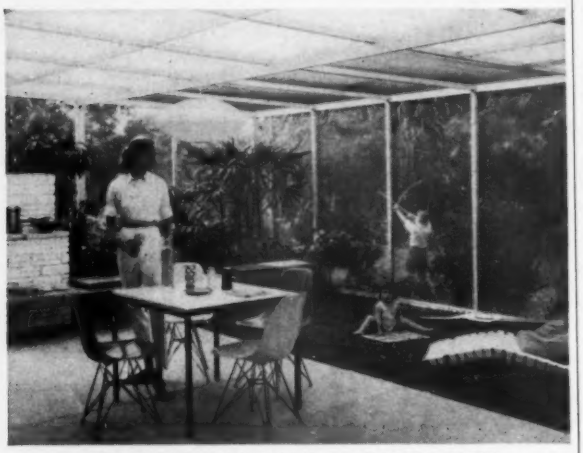


PHOTO COURTESY OWENS-CORNING FIBERGLAS CORPORATION

1950 Becoming increasingly popular today is screening woven from vinyl-coated glass fibers. Unaffected by sustained exposure to heat and cold, such screen materials resist acids, oils, salt air; they are rustproof and stainproof. In addition, glass screens resist impact; they will not shrink, stretch, or support fire.

1890 Michigan Alkali Company, now a division of Wyandotte Chemicals Corporation, was founded by Captain I. B. Ford to supply Soda Ash to the glass industry. At Wyandotte, there is no compromise with quality — insured by rigid tests from arrival of limestone at our docks (above), to final delivery of Soda Ash. Another reason why Wyandotte is a dependable source of raw-material chemicals for glassmakers.

Wyandotte CHEMICALS

Michigan Alkali Division, Wyandotte Chemicals Corporation
Wyandotte, Michigan • Offices in principal cities

Founded by a Glassmaker to Serve the Glass Industry

Glass Division Papers . . .

(*Continued from page* 348)

showed promise as protectors for glass to metal seals. Such tests were made by exposing the protecting materials to 100 per cent humidity for 1000 hours.

When investigators are working with such glasses, safety precautions are necessary and essential to guard against health hazards.

Evaluation of Several Infrared Transmissive Glasses was written by R. B. Grekila and H. D. Root, Westinghouse Electric Corp., Pittsburgh, Pa. The paper was presented by Dr. Root.

The study of special glass compositions was made to survey probable infrared transparent window material. Air Force usage has developed the term "irdomes" as an abbreviation of "infra-red domes."

In promising glass systems in which infrared transmission is a criterion, compositional adjustments of many kinds may be made which have direct and interesting effects on transmission. It has been demonstrated that a wide range of glasses can be made, that most of these have substantial infrared transmissivity, and that the compositions were all taken from systems in which the refractoriness is known to be sufficient to consider application as irdome materials.

Primary requisite for an irdome is that it transmit 80 per cent of all indirect radiations from 1 to 6 microns. The effect of temperature on infrared transmission is of considerable interest since air friction at high speed may heat the surface of the irdome. Three types of glasses are used in irdomes:

1. Barium-tellurium-lanthanates
2. Barium-titania-silicates
3. Barium-calcium-alumina-silicates

Although a wide range of glasses is possible, refractory glasses have been selected as preferables for irdome material. The glasses must withstand atmospheric moisture, rain, abrasion, be durable, and possess high infrared transmission. Much data were reported on infrared transmission.

The elimination of water influence and of moisture was proposed by vacuum-induction melting. It is hoped that this melting will eliminate the effects of moisture on infrared transmission. Irdomes may find application in areas where radar is now used.

Sylvatrons: Electroluminescent Solid State Devices for Visual Information Display was written and presented by Richard M. Rulon, Sylvania Lighting Products, Salem, Mass. This paper afforded an interesting demonstration of newer lighting and proposed means of lighting.

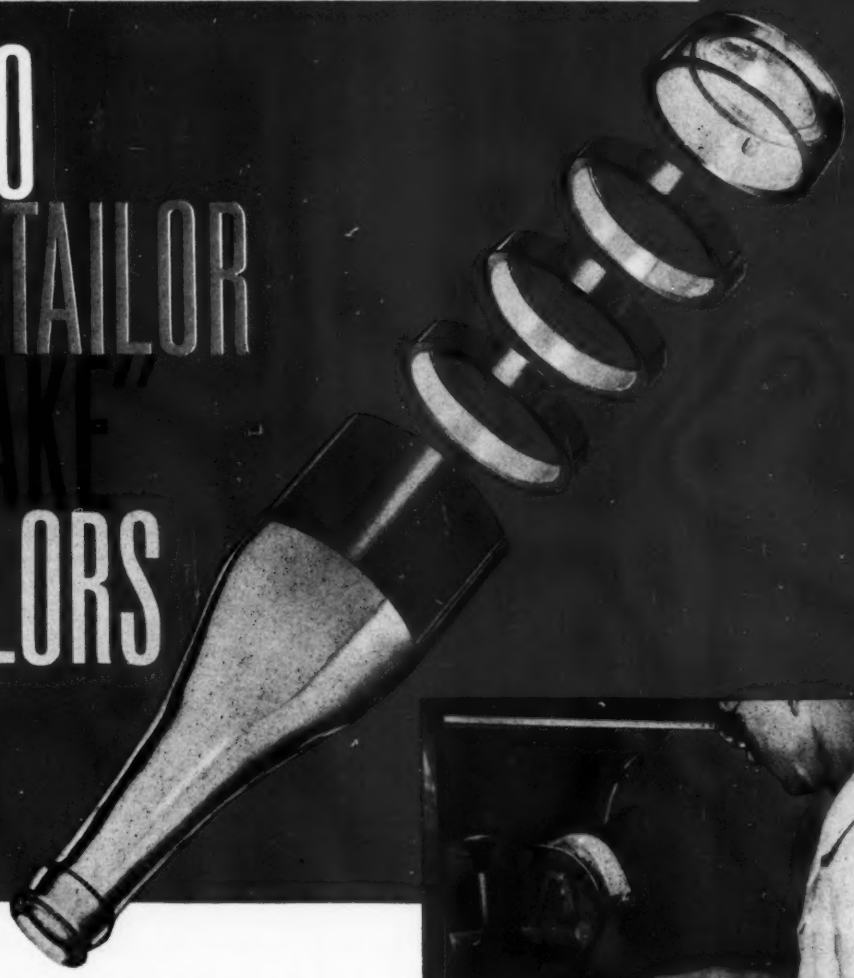
A discussion was given concerning three basic types of information display devices: image converter or light intensifiers, information storage panels, and moving dot signal panels. Each of these was demonstrated and analyzed on the basis of design and operating characteristics such as brightness, resolution, speed of response, power requirements, and application.

The role of ceramics and photoconductors in the development of these compact, durable, and versatile solid state devices for the display of visual information

(*Continued on page* 352)

HOMMEL "TEARS-DOWN" BOTTLES

TO "TAILOR MAKE" COLORS



Constant research on glass color printing is a never-ending program in the research and development laboratory at Hommel. Careful analysis of research problems accurately determines the "fit" of Hommel enamel to the glass.

Color coefficients of expansion are perfected for the glass used. Ring-sections of color-fired bottles are minutely studied under a polarizing microscope.

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Separation of rare earths by ion exchange is typical of Lindsay's pioneering which, nearly 20 years ago, made possible the production of Cerium Oxide in both mirror grade and in optical grade for glass polishing.

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Glass Division Papers . . .

(*Continued from page* 350)

from electronic or optical signals was emphasized. Some of the current applications are:

1. Visual display.
2. High-speed motion picture (400 frames per sec.).
3. High-speed computer read-out application (These are especially useful where read-out time is so much slower than computer production).

Medical application with X-ray equipment was also suggested where limited exposure is necessary.

These ceramic materials may also replace present fluorescent techniques and may be used as picture-on-the-wall television. Further developments for use in computer applications, radar traffic control equipment, and cathode ray tube replacement were predicted. The field of application seems limited only by the imagination and technical skill of the investigator.

The Wednesday morning session was under the chairmanship of N. M. Brandt, Mellon Institute, Pittsburgh, Pa.

Attack of Glass by Chelating Agents was the initial paper, given by F. M. Ernsberger, Glass Division Research Laboratories, Pittsburgh Plate Glass Company, Creighton, Pa. A chelating agent was described as a material possessing the ability to hold with more than one bond. Thus it is an agent capable of pulling glass into solution.

Two classes of chelating agents were found to accelerate the attack: those which act on the protective cations, and those which act on the silicon ion itself. The cooperative effect of both classes of agent under optimum ph conditions gave a 36-fold increase in the attack rate. Etheline-diamine-tetra-acetic acid (EDTA) and Catechol ($C_6H_4O_2$) are examples of these two classes.

The rate of attack of weakly-alkaline aqueous solutions on plate glass was measured by a simple interferometric technique. The number of rings per hour was taken as a measure of the rate of attack. Curves were plotted showing characteristic rate of attack and the interpretation of data was enhanced by means of excellent photomicrographs of the etched surfaces. The etched surfaces were comparable to and indistinguishable from a surface etched to a comparable depth with hydrofluoric acid. It was concluded that hydrofluoric acid is still unique in its attack on glass and, at present, is believed to exceed any other known materials.

The Solubility of Silica in Nitric Acid Solution was written by Thomas H. Elmer and Martin F. Nordberg, Glass Research and Development Laboratory, Corning Glass Works, Corning, N. Y.

The paper was presented by Dr. Elmer. Porous glass of a Vycor composition and silica gel were treated with nitric acid of varying concentrations. The analysis of dissolved silica served as a measure of the attack.

The solubility was found to depend on the acid concentration, decreasing with increasing strength of free HNO_3 in accordance with the following equation: $\log C = -a\,N - B$, where C and N are silica solubility and acid normality, and a and b are empirical constants respectively (at 95° C. $a = 0.168$, $b = 0.332$). The

(*Continued on page* 356)

Here is proof that LU-spar #1 is tops in QUALITY, ECONOMY

Two factors in 20 mesh glass grade spars which can be accurately computed are the feldspar's chemical analysis, and actual net cost per ton of alumina after dollar credits for sand and alkalies have been deducted. The formula below will demonstrate the superiority of LU-spar #1 in chemical value and lower cost.

YOU CAN PROVE TO YOURSELF THAT LU-spar #1 COSTS LESS PER TON ALUMINA (based on Parkersburg, W. Va. typical costs)

Sand: 67.8% x 2000 lbs. x 5.21 tons = 7064 lbs. of silica at $.00277 per lb. =	$19.57
Alkalies: 20.7% x 2000 lbs. x 5.21 tons = 21.57 lbs. alkalies at $.0181 per lb. =	$39.04
Discount: 2% 10 day discount = $.20 per ton x 5.21 tons =	$ 1.04
TOTAL LU-spar #1 DOLLAR CREDITS	**$59.65**

C-(D+E)=F

IN THIS FORMULA WHICH TAKES INTO ACCOUNT SILICA AND ALKALI DOLLAR CREDITS **(A x B = C)**

A = 5.21 tons of spar necessary to make one ton of alumina.

B = delivered price per ton of spar.

C = gross price per ton of delivered alumina.

D = sand dollar credits (% of SiO_2 ÷ 99.5% x 2000 lbs. x 5.21 tons = lbs. of SiO_2 x delivered cost per lb.).

E = Alkali dollar credits (% of alkali ÷ 58% x 2000 lbs. x 5.21 tons = lbs. of alkali x delivered cost per ton.).

F = net cost per ton of alumina.

USING THESE AVERAGE CHEMICAL ANALYSES

	Lu-Spar #1		SPAR "A"		SPAR "B"	
	ACTUAL	CORRECTED	ACTUAL	CORRECTED	ACTUAL	CORRECTED
SiO_2	67.5÷.995*=	**67.8**	67.6÷.995=	**67.9**	67.8÷.995=	**68.1**
Al_2O_3	19.2	19.2	19.2	19.2	19.2	19.2
K_2O & Na_2O	12.0÷.58†	**=20.7%**	11.2÷.58	**=19.3**	11.5÷.58	**=19.8**

*% of silica in glass sand. †% of active alkalies in soda ash.

	Lu-Spar #1		SPAR "A"		SPAR "B"	
Gross cost per ton of Alumina	$110.81		$110.81		$110.81	
Less Credits	59.65		55.99		57.00	
Sand and Alkali credits	$58.61		$55.99		$57.00	
2% Discount Credit	1.04					
	59.65		55.99		57.00	
NET COST OF ALUMINA		**$51.16**		**$54.82**		**$53.81**

Write us if you would like an actual price computed for you, based on this formula.

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ANCHOR HOCKING NAMES W. B. SNELL, JR. MANAGER OF CORRUGATED DIV.

W. B. Snell, Jr., vice president, manufacturing, Anchor Hocking Glass Corporation, Lancaster, Ohio, has announced the appointment of W. H. Cook as manager of the corporation's Corrugated Container Division, effective May 10, 1958. Mr. Cook has been with the Company since 1931, serving in various capacities in the Paper Box and Purchasing Divisions. He has been assistant manager of the Corrugated Container Division since 1953. Mr. Cook is a member of the Technical Association of the Pulp and Paper Industry. He succeeds P. A. Parker, retired.

P. A. PARKER, ANCHOR HOCKING, RETIRES

Paul A. Parker, Manager of the Corrugated Container Division of Anchor Hocking Glass Corporation, Lancaster, Ohio, since 1939, retired May 10.

Mr. Parker was employed by The Hocking Glass Company in 1929 to install and manage a corrugated box plant at one of its Lancaster, Ohio plants. He has been associated with this company and its successor since that time.

His duties included supervision of corrugated board converting plants and carton assembly departments of Anchor Hocking located at Connellsville, Pa., Salem, N.J., Winchester, Ind. and Jacksonville, Fla., in addition to Lancaster. Mr. Parker also headed the Carton Laboratory, a section of the Anchor Hocking Package Engineering and Research Center at Lancaster, Ohio.

Since 1939 Mr. Parker has been a member of th Packaging Committee of the Glass Container Manufa turers Institute, Inc. He served as chairman of the Co mittee for three years. He is currently chairman the Machine Made Glass Group of the Packaging Co mittee of the American Glassware Association.

A native of Cleveland, Mr. Parker graduated fr Ohio Wesleyan University, where he was affiliated wi Phi Delta Theta fraternity. He served in World War with the 83rd Division with the rank of First Lieutena Field Artillery.

Following discharge from the armed services in 191 Mr. Parker was employed by the Fairfield Paper Co pany, Baltimore, Ohio, where he became superintende of their corrugating plants. He remained there un 1929, when he joined The Hocking Glass Company.

In 1943-44 Mr. Parker served as paper consultant the Office of Civilian Requirements of the War Produ tion Board at Washington, D. C.

AMERICAN POTASH ELECTS C. R. LINDSAY AS DIRECTOR AND VICE PRESIDENT

The board of directors of American Potash & Chemic Corporation on May 2 increased the number of directo from nine to ten and elected Charles R. Lindsay, III, director and vice president of the company. Lindsay president of Lindsay Chemical Division of America Potash. The merger of Lindsay Chemical Company int American Potash & Chemical Corporation became effe tive on May 1.

Model NECO-2A is outfitted with lights, access ladder, incorporates piping.

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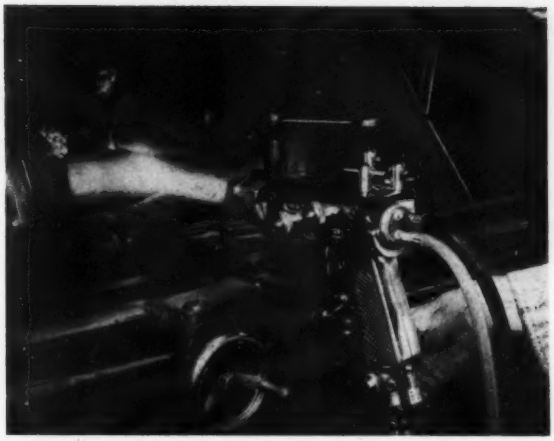
PETROLEUM
Esso Standard Oil Company
Pan Am Southern Corp.

GENERAL
American Can Company
Jones & Laughlin Steel Corp
Kaiser Aluminum Company
General Tire & Rubber Co.

Here's how to cut production costs

Glass machinery parts last longer with Colmonoy hard-facing alloys*



Making glass machinery parts last longer is the cost-cutting achievement of Colmonoy hard-facing alloys. They are used in many forms, such as oxy-acetylene rod, castings, paste, and powder. Colmonoy serves progressive glass container manufacturers the world over.

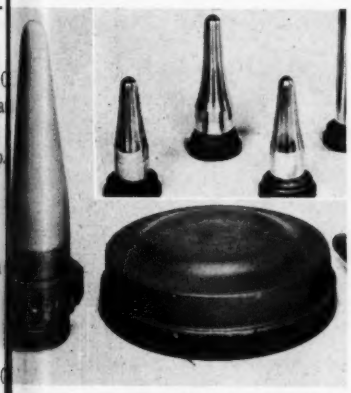
Many successful Colmonoy applications are done by the Colmonoy Sprayweld* Process. Here Colmonoy alloys (Nos. 6, 5, or 4) are sprayed on the wearing surface. This overlay is then fused to the base metal with an oxy-acetylene torch. The welded overlay resulting may be ground to mirror-smoothness.

Only Colmonoy Sprayweld alloys contain chromium boride crystals in a nickel alloy base. These powdered alloys are applied with the Colmonoy Spraywelder*, a metal spraying unit that uses compressed air to provide the force needed in building dense, porosity-free deposits. Photo shows the Spraywelder mounted on a tool post, spraying a rotating glass plunger.

Colmonoy Applications

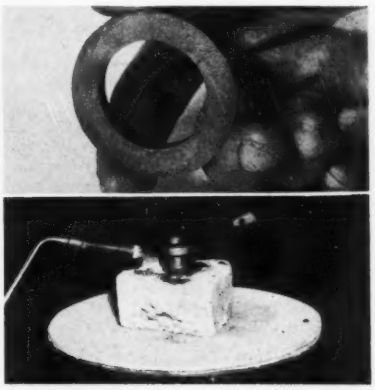
PART	ALLOY
Cullet Chutes	Colmonoy Sweat-On* Paste, torch fused.
Cullet Hammers	Colmonoy No. 1 electrodes
Timing Buttons	Colmonoy No. 6 oxy-acetylene rod
Blowheads	Colmonoy No. 4 Sprayweld powder
Baffles	Colmonoy No. 4 Sprayweld powder
Glob Cutters	WCR-100 oxy-acetylene rod
Take-out fingers	Colmonoy No. 5 Castings

If your "problem part" isn't mentioned here, tell us what it is, along with information on conditions encountered.



ove are two plungers hard-faced with the monoy Spraywelder and Colmonoy No. 6 oy, shown before grinding. Inset photo ows finished air-cooled plungers that last times longer with Colmonoy. Request Engeering Data Sheet 43.

Chipped and cracked areas in glass moulds, neck rings, and related cast iron parts are easily repaired with Colmonoy No. 20 oxy-acetylene rod, and are finished by filing. Engineering Data Sheet No. 36 gives full instructions.



Thimble inserts (top) made of Colmonoy No. 4 give cast iron thimbles 3 times longer life. Stock inserts are easily machined to size, are silver soldered (bottom), or press fitted into place. Request Engineering Data Sheet No. 42.

Manufacturing Factories in:

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GREAT BRITAIN: Motherwell
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Glass Division Papers . . .

(*Continued from page* 352)

rate of solution of silica depended on acid concentration, initial rate being maximum at about 0.8 N. The amount of silica dissolved is a function of time and acid concentration. For short periods of time (1 to 40 hours) a maximum amount of silica was dissolved in about 0.8 N HNO_3. For long periods of time this maximum was at 0.1 N or less. A curve showing the decrease in silica solubility with temperature in water was included.

The porous glass and silica gel showed a marked similarity of solution. The data are believed to be useful in showing durability of fiber glass as well as massive glass surfaces.

The Use of Ceramics in Electroluminescent Light Sources was the final paper, by Richard M. Rulon and David L. Cole, Sylvania Lighting Products, Salem, Mass. The paper was presented by Dr. Cole.

An excellent history of electroluminescent light sources was presented. Through the use of ceramics, many improvements have been made over the organic-type materials previously used in lighting. For example, glassy frits have shown good results. The organic-type dielectrics are not as durable as ceramics and, therefore, have a definitely limited useful life. The paper also discussed a frit phosphor of considerable promise in which the coefficient of expansion (both frit and base) and chemical compatibility (frit and phosphor) are important considerations.

The versatility of luminescent lamps is great and the introduction of ceramics has provided even broader applications. At present, these lamps are used in computers, instrument dials, and in varied military equipment. However, luminescent efficiency does not equal fluorescent efficiency.

In addition to the papers presented in the Glass Division, two papers of interest to glass technologists were given in the Basic Science and Design Divisions.

Silicone Advances in Glass Container Manufacture was presented by J. A. Stapp, Silicones Division, Union Carbide Corporation, Tonawanda, N. Y.

The glass container industry is now undergoing a transitional process in replacing the traditional paraffin oil or other organic forming lubricants with water base materials. Foremost among the water base materials are silicone emulsions. The emulsions of silicone oil are used diluted to low concentration in water to furnish excellent lubrication of shear blades, delivery equipment, and blank molds.

This excellent lubrication is obtained without the annoyance of smoke. Per cent packs obtained with organic lubricants were equaled or exceeded. The use of silicones contributed to longer shear blade life, cleaner, faster gob delivery, and less blank mold swabbing and changing. The use of silicones on shears and delivery has not presented any problems because the silicone directly replaced the previously used lubricant and used the same spray application methods. However, the use of silicones on blank molds has been slower to develop, mainly because of lack of a proper spray application. The sight feed dripper and copper tube spray used with organic lubricants is entirely unsatisfactory for use with silicones. The main reason for this difficulty is that the silicone oil in the silicone emulsion is nonvolatile in nature and will not coat the mold properly unless applied with an atomized spray pattern.

There are two types of emulsion now being used in the glass industry. Type I is an oil-in-water emulsion containing 35 weight per cent dimethylpolysiloxane fluid. The balance of the emulsion is water and emulsifying agents. Type II is the same as Type I, but colloidal graphite has been added. Equally good results have been obtained with each type. Either Type I or Type II emulsion is used on blank molds. For this usage, the dilution most generally used is 80:1.

An important advance in blank mold lubrication has been the recent availability of a spray kit to adapt a Hartford Empire I-S machine for silicone blank spray economically and quickly. The spray device is mounted on the invert post and consists of a double swivel nozzle. A system found quite suitable for Lynch 10 machines consists of two nozzles mounted below and slightly in front of the open blank mold at the station after the parison has parted. The use of silicones has also been successful on straight press machines.

Hardness - Temperature Characteristics of Some Simple Glasses by J. H. Wesbrook, General Electric Research Laboratory, Schenectady, N. Y., was presented in the Basic Science Division.

The indentation hardness of fused silica, fused germania, fused beryllium fluoride, synthetic soda-silica glass, and commercial soda-lime-silica glass were determined as a function of temperature. In general, hardness decreased steadily with increasing temperature, more rapidly at high temperatures. Silica based glasses showed irregularities in the vicinity of 70° and 570° C., the latter apparently associated with the quartz inversion. The effects of atmosphere can also be demonstrated with this technique.

Creston H. Doner, director of design and color, Libbey-Owens-Ford Company, Toledo, Ohio, showed to the Design Division over 200 dramatic Kodachrome slides illustrating new uses of color, light and glass.

At the business meeting of the Glass Division, the standing committee reports were presented, and the importance of continuing and improving abstracts of Soviet literature was emphasized. The International Commission on Glass is planning another International Conference at Munich in the summer of 1959.

The Division officers for the coming year are as follows: Trustee, Leonard G. Ghering, Preston Laboratories, Box 149, Butler, Pa.; chairman, N. M. Brandt, Mellon Institute, 4400 Fifth Avenue, Pittsburgh 13, Pa.; vice chairman, F. R. Bacon, Owens-Illinois Glass Company, Toledo, Ohio; secretary, F. V. Tooley, 611 W. Oregon, (University of Illinois) Urbana, Illinois.

The new Program Committee is as follows: Chairman, R. K. Day, 307 W. Harrison, Maumee, Ohio; C. L. Babcock, Owens-Illinois Glass Company, Toledo, Ohio; and R. D. Maurer, Corning Glass Works, Corning, N. Y.

The Fall Glass Meeting will be held at the Bedford Springs Hotel, Bedford, Pennsylvania, October 15-17.

The Annual Meeting of the American Ceramic Society will be held at the Palmer House, Chicago, Illinois, May 17-21, 1959.

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